The Automobile

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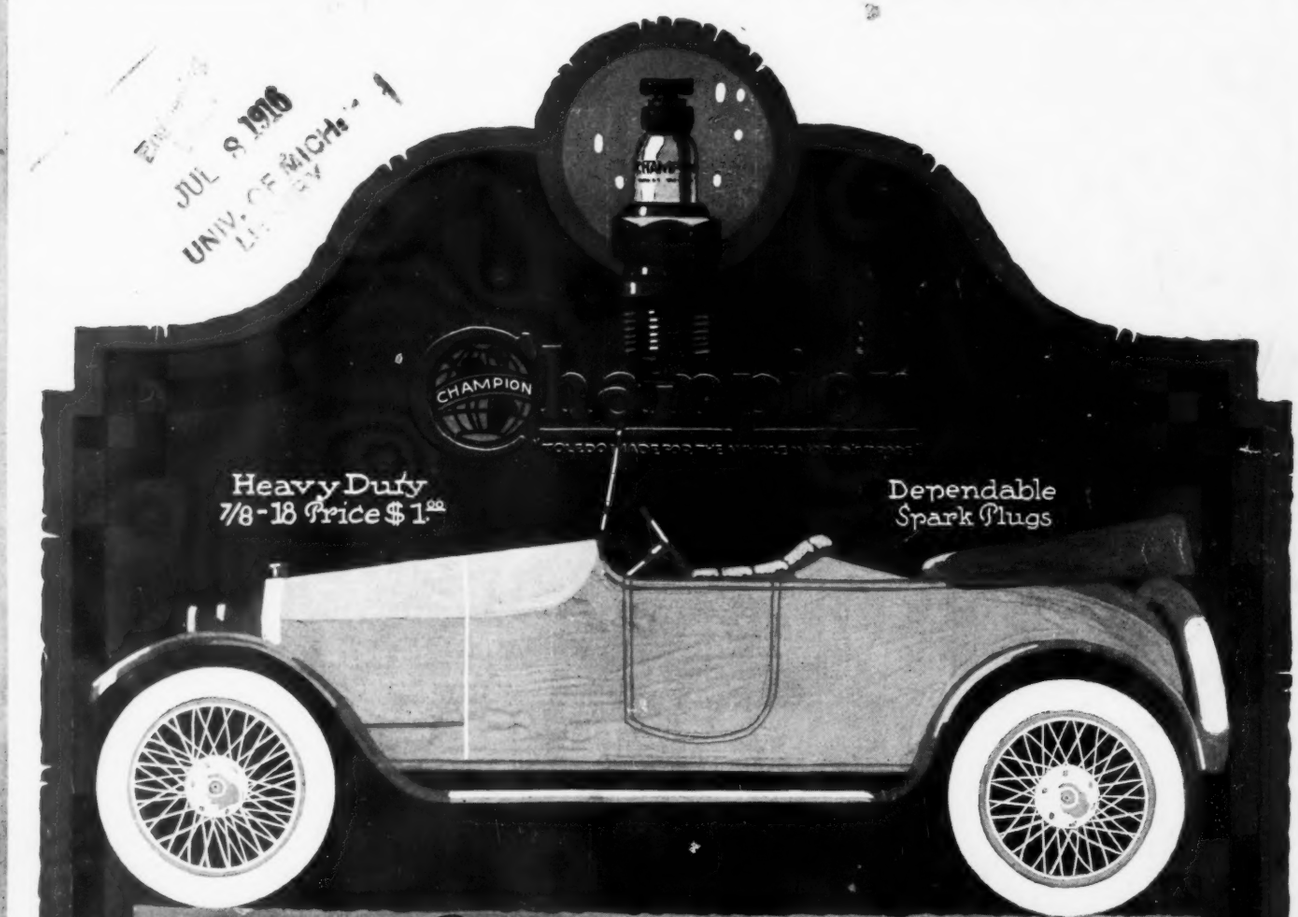

Scripps-Booth

"Companion to the World's best cars."

Scripps-Booth cars are invariably found in a quality environment--companions in every sense to the larger, costlier cars of men who can afford the best. It is significant that a car built for such a clientele should be equipped at the factory with "CHAMPIONS," spark plugs of quality for quality cars.

CHAMPION SPARK PLUG CO, 1011 UPTON AVE., TOLEDO, OHIO.

Suggestion No. 19

Stewart Warning Signal

$3.50

Hand Operated

EVEN a weak little buzzer or an old time bulb horn sounds big and commanding when demonstrated indoors.

Motorists are demanding for their life's sake a signal that sounds sure safety out in the din of traffic.

So many thousands demanded this Stewart Safety last year that our production is doubled and the price lowered to $3.50.

Display this Stewart.

It sells itself.

"No car is better than its accessories"

The Stewart-Warner Speedometer Corporation
Chicago, Illinois, U. S. A.

The AUTOMOBILE

VOL. XXXV NEW YORK—THURSDAY, JULY 6, 1916—CHICAGO NO. 1

De Palma Wins Twin City 150-Mile Race

His Mercedes Averages 90.8 M.P.H. for the Distance—Aitken Second—Christiaens Third —Poor Gate Almost Causes Postponement

MINNEAPOLIS, Minn., July 4 — *Special Telegram*—Ralph De Palma at the wheel of his cream-colored Mercedes was the bright particular star to-day of the sadly curtailed Mid-Continent races at the Twin City speedway. The veteran driver tooled his German-built American mount into first place early in the 150-mile event and held that position for a win. His time was 1:38:49.20, an average of 90.8 m.p.h. Aitken in the Peugeot put up an exciting battle but finished second, 1 min. and 25 sec. behind De Palma. His time was 1:40:14.5. Christiaens, whose English Sunbeam led De Palma for the first 8 miles and again from the twentieth to the fortieth mile posts and menaced De Palma's supremacy for 65 miles, took third in 1:43:28.75. This was 2 min. behind Aitken and over 5 min. behind De Palma.

The remaining four cars of the seven to finish in the money were Milton, Duesenberg, fourth, time 1:44:-11.95; O'Donnell, Haskens special, a Duesenberg machine, fifth, time 1:47:37.95; Sorenson, Marse, sixth, time 1:56:14.45; Muller in Dans L'Argent, a special job with a Hudson motor, seventh, time 2:1:18.20. The last car to finish just barely lived up to its name Dans L'Argent, or "in the money."

Race Nearly Called Off

Until almost 4 o'clock prospects of any race at all were dubious indeed, not that there were not starters enough, for fourteen cars were ready for the signal, not that the track was any worse than normal, for, while there were clouds and showers in the morning the sky was clear and the sun shining by 11 o'clock, but because the promised $20,000 supposed to be hung up as prize money for the four events of the day was not forthcoming. The program scheduled four races, 150 miles, 50 miles, 20 miles and 10 miles, respectively, with the big event of 150 miles to start at 2 o'clock, but at that hour the grandstands and parking spaces were disappointingly bare, the expected crowd having failed to materialize, due to the morning's rain and to lack of proper advertising of the races. The speedway management had counted on the gate receipts to provide the funds for the prize money, and seemingly the total of the advance sales and the gate receipts did not amount to much more than $8,000 of the $20,000 announced prizes. W. C. Barnes, A. A. A. representative, refused to permit the race to start until the prize money had been placed in his hands as required by the rules of the association. The sparsely-settled grandstands were becoming impatient by 3 o'clock when Barnes called a meeting of the drivers, who first offered to stage a 10-mile exhibition for no prize if the management would return their money to the ticketholders. This not being received with enthusiasm by the management, it was decided to run the 150-mile event only for the $8,000 cash and Manager Sperry's check for the balance secured by speedway stock, Starter A. C. Bennett then sent the fourteen cars away at 3:55, nearly 2 hr. late.

The afternoon events began by the review of the State troops by Governor Burnquist, and this also may add to the difficulties of the speedway management for the contract with the State that the exhibition of the militia calls for a payment of 10 per cent of the gross receipts to the soldiers' fund. Now the State threatens to bring suit.

(*Continued on page* 42)

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Buick Adds a Four

NEW YORK CITY, July 1—The General Motors Co. has again entered the four-cylinder field with a four-cylinder runabout, known as D-4-34, and touring car, known as D-4-35, selling at $650 and $665, respectively, f.o.b. Flint. The company will concentrate on this model and its small six, having discontinued the large six.

The new four-cylinder model will be designed for an initial production of about 75,000. The motor is of the same overhead valve construction as the present six and is 3⅜ by 4¾, developing 35 brake hp. Other specifications include: 106-in. wheelbase, Delco ignition, Stewart vacuum fuel feed, 31 by 4-in. non-skid tires, three-quarters floating rear axle, semi-elliptic springs on both front and rear, the front being 30 by 2-in. and the rear 48 by 2. The car has three speeds forward and is geared 4 to 1 on high.

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New York and Chicago Show Dates Jan. 6 and Jan. 27

NEW YORK CITY, June 30—The National Automobile Chamber of Commerce has announced the 1917 show dates. The New York show will open at the Grand Central Palace Jan. 6 to 13, inclusive, while the Chicago date is Jan. 27 to Feb. 3, inclusive.

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Want Funds for Aeroplanes

Aero Club Appeals for Assistance in Sending Planes to Mexican Border

NEW YORK CITY, July 5—The Aero Club of America has sent out a strong appeal for funds to enable private enterprise to raise a fleet of military aircraft which can be presented to the government. In the letter the club states that it feels Congress should provide the money. The U. S. army to-day has but twelve aeroplanes and there are but fifteen army aviators, yet every aeroplane is worth 1000 soldiers in campaigns such as that which may still have to be fought along the Mexican frontier.

"Aeroplanes are necessary to protect the lives of the thousands of soldiers participating in the Mexican expedition. The Aero Club of America is mobilizing the licensed aviators available, equipping them with high-powered aeroplanes, and keeping them in readiness to await the call of the War Department, which will gladly avail itself of this reserve in case of need. It will cost between $400 and $750 to train each aviator, and between $8,000 and $10,000 each for the high-powered military aeroplanes."

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Peterson Joins Alloy Steel Spring

JACKSON, MICH., July 1—F. J. Keiser, superintendent of the Alloy Steel Spring Co., has resigned, and is succeeded by Gustave Peterson, now with the Carnegie Steel Co. at Detroit.

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Fergus Car for Next Year

NEW YORK CITY, July 3—In a large office at 80 Maiden Lane, this city, J. B. Ferguson is working on the drawings of the Fergus car which created such great interest at the last New York show, in order to get it into shape for manufacturing. Up to the present the exact location of the plant has not been chosen, but it is certain to be close to New York. Mr. Ferguson expects to have the first cars ready for the market in about 10 months and plans an output of well under 1000 for the first year. It has been necessary to raise certain portions of the chassis to suit American road conditions, but the car will be altered in no essential feature otherwise.

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Loomis Resigns from Packard

DETROIT, MICH., June 28—Allen Loomis, for the past 10 years with the Packard Motor Car Co., this city, has resigned his position as research engineer to devote his attention to private engineering. An announcement regarding the details of his new work will be made after Mr. Loomis' return from his summer home at Higgins Lake. During his connection with the Packard company, thirty-nine patents were granted Loomis, many of which are embodied in the current Packard cars.

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Earle and Boggs Leave Continental

DETROIT, MICH., June 29—L. H. Earle, sales manager and G. A. Boggs, assistant sales manager of the Continental Motors Co., this city, have resigned and will become actively engaged in business together in the East.

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Elliott, Haynes Production Manager

GRAND RAPIDS, MICH., July 3—E. M. Elliott, formerly in charge of the production of the United Motor Truck Co., Grand Rapids, Mich., and since then in charge of sales of the Mais trucks, has been made production manager of the Haynes Automobile Co., Kokomo, Ind.

Night stop of record-breaking King eight for supplies. Time and duration of stop checked by A. A. A. observer

King Covers 10,850 Miles in 2 Weeks

Averages 32 M.P.H. — Parallels 2 Years in Owners' Normal Service

SHEEPSHEAD BAY, June 29—Just a little after noon to-day the King eight-cylinder car, which has been undergoing a non-engine-stop test for the last 2 weeks, rolled across the finishing line of the board track here having covered practically 10,850 miles without a falter in its power plant.

The object of the test, which started at noon on June 15, was to demonstrate the stability of the King eight-cylinder engine and to approach a condition of actual service by concentrating the running and operation of 2 years' car service into 2 weeks of test work. To accomplish this the car maintained an average of over 32 m.p.h., including the stops to take on gasoline, oil and other supplies. Excluding the stops the speed was 34.31 m.p.h. The engine ran 24 hr. a day and was not stopped from the moment the test started until it was switched off by F. E. Edwards, technical representative of the A. A. A., before the New York King salesroom late this afternoon.

The test was methodically arranged and carried out from start to finish. It was under direct sanction and supervision of A. A. A. officials, who worked in shifts of 8 hr., observing the running of the car and noting, on the score sheet, the time of each lap around the 2-mile track. The drivers worked in shifts of 5 hr., with a 10-hr. rest period and with the driver rode a mechanic giving a full passenger load in the front seat while in the rear a bag of sand weighing 500 lb. was carried to represent the full passenger load in the tonneau.

The entire 10,850 miles were run upon the speedway except 200 miles which were made upon the roads of Long Island between the speedway and the Motor Parkway and on the Motor Parkway itself up and down the 40-mile stretch from Jericho turnpike to Lake Ronkonkoma. No attempt was made to speed the car excessively but the average was held consistently throughout the run. The car probably made its fastest time when put on the Motor Parkway, as it traveled at times close to 50 m.p.h. over the rolling country traversed by the parkway. Even at this speed, however, due to interruptions to and from the parkway, the average speed while off the board track dropped to about 26 m.p.h., showing the impossibility of maintaining a high average over the open roads.

As a service test of the car, the King company makes the point that this shows

actual performance as well as it possibly can be shown in a test because the distance covered by the car is equal to about 2 years of normal driving and the speed is not very far in excess of that often demanded by the car owner. The King car which made the test was certified by the King company and by A. A. A. officials to be a strictly stock job throughout, even including the details of equipment. This is a Model E car with an eight-cylinder, 3 by 5-in. motor, having an S. A. E. rating of 28.8 hp. and a piston displacement of 282.7 cu. in. The motor is a product of the King plant and follows conventional eight-cylinder practice with the cylinders cast in blocks of four at 45 deg. The valves are on the inside of the V and are operated from a chain-driven camshaft. Cooling circulation is by thermo-syphon, lubrication is by pressure and ignition by single Atwater Kent battery system.

Gasoline is fed by the Carter system to a Ball carbureter. Starting and lighting is by Ward Leonard. The drive is taken through a plate clutch through a three-speed unit plant gearset through a floating American rear axle. The gear ratio used on the test car was a standard 4.25 to 1 and the tires 35 by 4 Firestone plain tread front and non-skid rear. The only fitting on the car which does not coincide with stock practice was an additional speedometer which was installed as a double check on distance. The official distance readings, however, were not taken from the speedometer but measured by the laps made on the speedway. While on the road during Saturday, June 24, while the speedway was occupied by the New York police in their field games, the distance was taken from the speedometers corrected by a coefficient determined from a comparison of the readings and the known distance traveled on the 2-mile track.

Total Stops 160

During the course of the run the car made 160 stops. On 69 of these changes of either driver or mechanic were made. Besides stops for supplies and changes of drivers the other causes for stops were as follows: Testing electrolyte of battery on several occasions, replacing bulbs, oiling universals, oiling speedometer drive, tightening grease cups, tightening fan belt, cleaning gas line, taping leak in gas pipe, tire changes, renewing motor oil, splicing horn wire terminal, steering gear adjustment, and at important distances, such as 10,000 miles, the car was stopped for photographs. Throughout the run no adjustments or mechanical work was done that could not be accomplished by the ordinary owner, this being one of the objects of the test. The weather conditions were very severe during many parts of the run, in one instance the fog being so thick that the driver could hardly stay on the track and m.p.h. There were several thunder storms during the course of the run, three or four of which amounted to practically cloudbursts and also two or three days of steady, misty rain. About half the time the weather was bright and fair.

One of the features of the run was the oil economy. The car averaged 1172.7 miles to a gallon of oil, in spite of the speed, which was considerably in excess of average driving, with the added factor that the motor did not stop running for an instant after the test was started.

Specifications of the King Model E Car

Price—$1,350.
Body—7 pass.
Color—
Make of engine—King.
No. of cylinders—8
Shape—V.
How cast—4.
Bore—3.005.
Stroke—5.00.
S.A.E. hp.—28.8.
Ignition—Atwater Kent.
Carbureter—Ball.
Gasoline feed—Carter.
Lighting system—Ward Leonard.
Clutch—Plate.
Gearset—Selective three-speed.
Wheelbase—120 in.
Tires—34 x 4.
Wheels—wood.
Speedometer—Stewart.
Make of axle—American.

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Jordan Starts Manufacturing

CLEVELAND, OHIO, July 3—The new plant of the Jordan Motor Car Co., 1054 East 152d Street, has begun production of cars for the trade. The specifications of the new car include the following: Six-cylinder Continental motor; Timken bearings and axles; Bijur starting and lighting system; Stromberg carbureter; Bosch ignition; Brown-Lipe transmission and clutch; Parrish frame; Willard storage battery Stewart-Warner equipment; Gemmer steering gear and Firestone tires.

Repair Plant for U. S. Army Trucks

7000 Machines to Be Kept in Proper Condition at Fort Bliss

EL PASO, TEX., July 1—Seven thousand trucks belonging to the United States Government will be taken care of in an immense repair shop located at Fort Bliss, if the plans of the United States Army are carried through.

There are now, or will be within the next few days, a total of 1050 trucks and about 125 touring cars and roadsters in army service along the border. Repairs at present are made at the camp at Columbus or in private plants.

Two thousand trucks and their tenders were asked for early in the week for immediate delivery. Another lot of 4000 was ordered last Thursday.

There will be fifty-two big lathes in the shops at Fort Bliss. Mechanics will be paid approximately $100 a month, but will be required to enlist in the regular army for a period of 1 year.

The contract for gasoline held by the U. S. Government has expired. It called for the delivery of gasoline along the border at 10 cents a gal.

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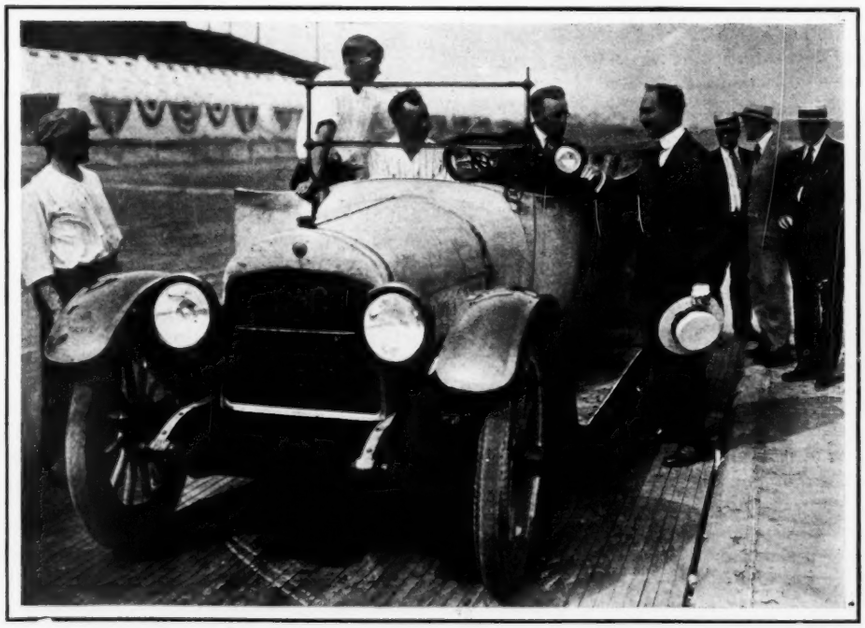
Chevrolet Purchases Warner Plant

TOLEDO, OHIO, June 29—The Chevrolet Motor Co. has purchased the plant of the Warner Mfg. Co. on Central Avenue, and will open it, about July 15 as a factory branch.



Artemus Ward, Jr., president of the King Motor Car Co., congratulating driver Grindell at the end of the 1000 miles. Left to Right—C. Jacobs of King experimental department in charge of test, drivers Benson, Cork and Grindell, Artemus Ward, Jr., H. C. Bradfield, advertising manager, T. P. Chase, chief engineer, and G. J. Bates, commercial manager

National Gas Engine Assn. Members Advocate Affiliation with S. A.E.

Chicago Meeting Discusses Advantages of Close Co-operation With Other Engineering Bodies— Many Papers—Views on Kerosene and Tractors

CHICAGO, ILL., June 29—To-day the convention of the National Gas Engine Association came to an end after 3 days in session at the Sherman Hotel. Affiliation with the Society of Automobile Engineers was broached informally at the business meeting yesterday, while John T. R. Bell, engineering representative of the Norma Co. of America, and who is a member of both societies, in the informal discussion, pointed out that the standards committee of the Gas Engine association has been working in very close touch with the standards committee of the S. A. E. and has adopted wherever possible the standards already in force among the automobile manufacturers, and also that two other associations in allied industries, the marine engineers and the aeronautic engineers, have asked to become affiliated with the Society of Automobile Engineers.

Inasmuch as complete plans for the co-operation of these societies have not been worked out as yet it was decided to defer action for the time being. Comment in general was favorable.

The standards committee adopted standard specifications for a number of features of gas engines, and it was notable that recommendations were, in so far as possible, to follow the present standards of the Society of Automobile Engineers. The association formally adopted a standard guarantee for gas engines warranting them to be free from defects in materials and guaranteeing replacement of parts proving defective in material for a period of 1 year. This does not include ignition or other accessories guaranteed by the makers.

At the election of officers the president, secretary and treasurer were re-elected, as were most of the vice-presidents and executive committee. C. E. Bement of the Novo Engine Co., Lansing, Mich., is president, R. H. Brate is secretary, and Otto M. Knoblock treasurer.

Many Tractor Papers

There were a number of papers and discussions on tractors, and another series on various ramifications of the fuel problem. Other papers of interest, from the manufacturing standpoint, included scientific management of factories, uniform methods of figuring costs, ignition selections, reducing shop cost, and an address by Dr. Frank R. Rutter, assistant chief of the Bureau of Foreign and Domestic Commerce, on the internal combustion engine in foreign trade.

That the former low price of gasoline is a thing of the past, is the belief of E. E. Grant, secretary of the Independent Oil Men's Assn. of Chicago, who in an address entitled the Fuel Problem as it Pertains to the Internal Combustion Engine discussed the present factors which have caused the rise in the price of gasoline and the probabilities of the future. He stated that it was his belief the average price of the future would be from 15 to 25 cents, and did not anticipate that the cost to the consumer would be very much less than 15 cents or very much higher than 25, at least for several years. He confirmed the general impression among gasoline users that the demand for motor fuel has become enormous and that quite frequently the quantity of fuel is increased by adulteration. He made a plea for co-operation between oil men and engine makers and proposed an association of gas engine, automobile, marine and aviation engineers, together with the oil men—experts who could work together for the solution of a proper fuel.

Crude Oil Increase 700 per Cent

He brought out the point that during the last 2 years the increase in the price of crude oil has been 700 per cent and in addition to that it often was necessary to pay premiums over the market price. He figured that the consumption of gasoline for 1916 would be 1,934,000,000 gal., but stated that much progress in increasing the yield had been made within the past year, and that at present 2 per cent of the gasoline is made from natural gas. The gasoline from this source has a low boiling point of 65 to 85 deg. Fahr. and a high boiling point of 300 deg. Fahr. He mentioned the fact that a process of pressure distillation for increasing the yield from crude was patented by a Dr. Parker as early as 1907, this antedating both the Rittman and the Burton process patent. He emphasized the need of the development of engines to use low-grade distillates, and stated that when the troubles with Mexico are over that country will be able to supply sufficient crude oil for the entire world. This, however, is not rich in gasoline. Seventy-five per cent of the oil industry in Mexico at the present time is owned and controlled by American capital. Mr. Hall also confirmed the general impression as to the decrease in gravity of motor fuel during the past 2 years. He stated that not long ago gasoline of 76 deg. Beaumé was common. Now it is not over 58 deg. and sometimes as low as 50. Within the next 2 years it will be somewhat below 50 deg. Beaumé. He said that gasoline users are gradually coming to kerosene and that before long we may expect to be using kerosene. He believes that within 5 years engines will be so designed and the distillation process so refined that of the crude oil 75 per cent will be used as fuel and the remaining 25 per cent as lubricant.

In the discussion of E. W. Roberts's paper on liquid fuels present and future, the fact was brought out that in England there has been considerable experimenting with the use of pulverized coal, and in Germany with naphthalene, no one, however, recalled the fiasco of a few years ago with Zoline, which was supposed to be chiefly naphthalene and water. The statement was made that it would not be surprising in a few years to see gas engines using coal as fuel. In confirming this Mr. Knowles stated that his company has been experimenting with coal in solution in water, that it could be pulverized so fine that it partakes of the nature of deflocculated graphite and can be atomized and ejected into a burner just the same as fuel oil, and that subtracting the heat necessary to dispose of the water there would be left 13,000 B.t.u. per lb. from the coal. The chief difficulty with its use in internal combustion engines would be the ashes.

In a paper dealing with tractor engines, W. J. McVicker anticipates a return to favor of steam. "The gas tractor created so much interest that the steam tractor was left in its undeveloped condition and we do not yet know its possibilities. It will not be at all surprising to see a revival in the development of the steam tractor, and it may even become a strong rival of the gas tractor. However, this will depend somewhat on the nature of other fuels available in the near future."

Maxims of Engine Design

The author discussed different types of engines which had been and are being applied to tractors and set forth the advantages and the disadvantages that had been encountered in each, concluding with a statement that a successful tractor engine must have the following qualifications regardless of its type:

1—It must be so constructed that it can develop its maximum power continuously without self-destruction. The element of limited overload must be eliminated because it cannot be controlled.

2—It must start and operate without undue loss of time and must do a season's work with ordinary care and without the services of an expert. Instructions that the user must spend considerable time each day in doing expert work in order to keep it going must be discarded from the instruction books, because time is too valuable during that

period and such advice will be ignored.

3—It must develop its rated power economically and operate successfully with the kinds of fuel common in the locality where it is used.

Possibilities in Small Tractor

In a paper on the modern gas tractor W. A. Horthy stated that the present-day machines are in a state of evolution and a long way from perfection. He considers that purely as a manufacturing proposition, the small tractor with its initial low cost, great flexibility and present-day popularity, seemingly offers the greatest possibilities. No progress in the development of four-wheeled tractors is being made in this country, although much experimenting is done abroad with good success. It seems as if the high price and unusual construction do not sufficiently balance the guaranteed advantages over two-wheel-drive tractors. Regarding kerosene Mr. Horthy holds very strong views which may be summed up as follows:

A few years ago the market was flooded with kerosene attachments. Their disappearance warrants the truth of the assertion that to have a kerosene-burning tractor means a whole lot more than to equip the engine with a special carbureter. There is but one way to burn low grade fuels perfectly in internal-combustion engines, that is the Diesel way. This principle of fuel injection into the highly compressed air of the combustion chamber—this rational burning, not exploding, at 500 to 600 lb. pressure, gives some startling demonstrations of economy and reliability.

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Hatfield Roadster at $875

SIDNEY, N. Y., June 30—The Cortland Cart & Carriage Co., this city, maker of the Hatfield roadster, suburban car, light delivery and light express cars, and which recently increased its capital from $75,000 to $225,000 to take care of a more active production of its products, is now making distribution of its cars within a comparatively small radius of this city. The company states that it will not build more than a few hundred cars for the next year or so.

The models are equipped with a four-cylinder L-head block engine developing 32 hp., the bore being 3¾ in. and the stroke 4¼. Other features include thermo-syphon cooling; selective sliding gear transmission with three speeds forward; disk clutch positively coupled to transmission; constant level splash lubrication; Connecticut ignition; Stromberg carbureter; Hotchkiss drive with two universal joints; semi-elliptic springs in front and full cantilever, floating in rear; Disco starter; and full floating rear axle.

The model H, three-passenger roadster sells for $875, the suburban car for $800, the light delivery for $820.

2400 Cars and Trucks for U. S.

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Bids Received for Motor Equipment Estimated To Be Worth $15,400,000

WASHINGTON, D. C., July 3—Bids have been received by the Quartermaster's Department for supplying the Government with 2000 trucks, half of 1½-ton capacity and half of 3-ton size. Simultaneously bids have been made for supplying 400 cars in touring and roadster bodies intended for dispatch carrying and for moving officers rapidly from point to point. The truck order is estimated to be worth about $15,000,000 and the order for touring cars about $400,000.

Naturally the Ford Motor Co. has made the lowest bid for the touring cars, offering them at $440 each, f.o.b. Detroit, and undertaking to complete delivery within 1 week from receipt of order. Another offer is of 400 Elkharts at $975 each, the company stating that it has a large stock on hand. The Colt-Stratton Co. offers 400 Dodge cars at $785, guaranteeing shipment to be started 1 day after receipt of order and completed within 4 days, thus beating the Ford delivery offer by 2 days.

Willys-Overland offers its six-cylinder model for $973.25 or the Willys-Knight at $956.25. Packard offers the standard seven-passenger touring car for $2,475, and has a hundred for immediate delivery.

Maxwell offers forty cars per day at $500 each, f.o.b. New York, or $475 each, f.o.b. Detroit. Other bidders include Reo, King, Velie, Hupmobile and Studebaker, some of these bids being made direct and some through dealers.

Big Truck Orders

On the truck order there have naturally been a very large number of bids, since it is impossible for any one firm to hope to execute the whole order. It is obvious that if this quantity was required hurriedly it would be necessary to buy in tens and twenties from almost every maker. One of the bidders offering the most rapid delivery is the Four Wheel Drive Auto Co., offering fifty-six 3-ton chassis by the end of August and stating that it can speed up at the rate of 224 per month.

The Chicago Pneumatic Tool Co. has 100 trucks of 1½-ton capacity for immediate delivery and can produce 150 per month. White offers two trucks per week, the Locomobile five trucks in 28 days and thirty in the following 3 weeks. Pierce-Arrow offers 700 2-ton chassis, 300 to be delivered by Jan. 1, 400 by April 1 and ten per day thereafter. Packard bid for thirty-three 1½-ton in 2 days after Aug. 1, the subsequent deliveries at the rate of thirty-three each 30 days and also for a certain number of 3-ton trucks. Jeffery has a 1½-ton bid, delivery at the rate of seven per day. Most of the other bids are for small quantities and far too numerous to mention. It is noteworthy that the specifications for the trucks were finally drawn up after consultation with a committee brought together by the Society of Automobile Engineers, including prominent engineers. Several meetings attended by government representatives were held at the S. A. E. office and the specifications as drafted originally were modified in some respects so as to enable greater output in a short time.

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Homer Laughlin Builds 8-Cylinder Front-Drive Car

LOS ANGELES, CAL., June 28—The Homer Laughlin Engineers Corp. of this city has completed three of the new Homer Laughlin eight-cylinder front-drive cars and the factory is now turning out ten machines on order.

The new Los Angeles built car has been more than 2 years in the rough and now that the factory officials are sure of their product, active car building is to follow. The car weighs less than 1700 lb. and sells for $1,050. The builders have taken over the large factory on Long Beach Avenue, formerly occupied by the McCann Mechanical Works and are building every part of the car with the exception of the electrical equipment, wire wheels and tires.

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Fostoria Raises Prices

FOSTORIA, OHIO, July 3—The Fostoria Light Car Co., this city, has raised the price of its 1917 touring car to $735; the delivery wagon with an open body to $695 and with a closed body to $715. The width of the rear seat has been increased from 39 to 46 in. and the front seat from 37 to 42 in. The car has a floating rear axle, Remy ignition with distributer and automatic sparker. The car is now equipped with a natural wood cowl dash upon which are located all of the instruments.

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Pathfinder Starts High-Gear Run

SAN DIEGO, CAL., July 4—*Special Telegram*—Twenty thousand people witnessed the start of the Pathfinder twelve on its high-gear run across the continent today. The start was delayed an hour by reason of officials not being able to check specifications and place seals on the car by 12 o'clock. At 12.30 the crowd around the car in the Plaza de Panama was so dense that police and exposition guards were necessary to clear a passageway.

Simple Tests Show Car Condition

How Acceleration, Speed and Fuel Economy Are Inter-connected—Power and Gear Ratio Relations Analyzed and Explained—Aids for Owners

By Charles E. Manierre

BEGINNING with the issue of April 17, 1913, THE AUTOMOBILE contained a series of four exceedingly interesting articles by Prof. W. C. Marshall on Detecting Resistance and Saving Fuel.

The experiments mentioned by him were made through the use of an English invention known as the Accelerometer. This instrument is about the size of a rather small alarm clock and is laid face up on some surface or bracket on the car where its needle indications can be read conveniently. It contains a levelling screw, but needs only to be strapped in position and is in no other way connected with the car. Its needle indicates on a scale three things only, viz., grade, resistance in pounds per ton, and acceleration in feet per second.

Two things have prevented this instrument from coming into general use, viz., its price, $52.50, and the knowledge of mathematics and physics which seemed to be necessary to its successful understanding.

Professor Marshall, in order not to take up too much space in THE AUTOMOBILE, condensed his articles so that every sentence was concentrated. It must have proved difficult reading except by those to whom acceleration in feet per second per second, resistance, momentum, gravity constants, torque curves and horsepower formulae were a daily diet. Nevertheless his article contained much of vital interest to every car owner and it is by no means necessary to own or use the instrument mentioned to get valuable results from the line of thought he followed.

For the practical man who wants neither exact mathematics nor science and who will never be on speaking terms with a torque curve, the study of Professor Marshall's article suggests two simple tests of the condition of one's car and engine.

Testing for Friction

Every car owner has at times the knowledge that his car is in fine condition and is running its full number of miles per gallon of gasoline. When this is so, let him pick out a convenient spot on the road near his home, bring his car to a definite speed and at a definite point on the road throw out his clutch and coast to a standstill and note the point where the car stops. Thereafter, whenever he wishes to test the friction of his machine from the gearbox to the rear wheels, and the rolling resistance, he can repeat the experiment at the same place and speed and can tell whether all is well, namely, whether he coasts as far. But he must remember that the passenger load, etc., must be the same and the tires must be pumped to a reasonable pressure.

The second experiment is for the engine, and is to be first made when the engine and car are running in extra good condition. It consists in selecting a hill not too steep to be ascended on high gear at, say, about 20 m.p.h. The test consists simply in determining with the throttle wide open what is the exact maximum speed of the car on the hill. Later on when it is desired to test the running of the engine it will first be necessary to try the coasting test; and be sure that some such evil as dragging brakes is not causing trouble. If the coasting test proves satisfactory, then diminished speed on the hill will reveal the need of attention to the engine, which is not delivering its proper horsepower. Of course the diminished mileage per gallon of gasoline will tell the same story, but it will not indicate, as the above tests will, whether the trouble lies in front of or behind the flywheel.

In the hill test, as in the other, the weight carried by the car must be the same as in the original experiment.

An Ability Diagram

Even though one has no intention of putting his engine through a series of exact tests, it is worth while to have knowledge of the subjects of grade, resistance and acceleration, and to have an intelligent comprehension of the facts which are revealed by a diagram showing curves of resistance, torque on several gears and grade. In fact such a diagram for a given car shows very completely its ability. It gives much more information than a mere horsepower curve.

No doubt manufacturers would be only too glad to display such a diagram as showing what might be expected of their respective cars if any considerable part of the public were prepared to appreciate the facts to be gleaned therefrom. In such case of course the diagram should indicate the performance of the car with its normal passenger load. The vertical lines on such a diagram would indicate speed in miles per hour, while the cross lines, beginning at zero at the bottom, would indicate resistance in pounds per ton of 2000 lb.

The first and most important curve would be a coasting resistance curve, starting at zero pounds and zero miles per hour, and sweeping upward to a rapidly increasing rate of pounds of resistance as the speed became great.

This resistance is exactly what would be shown if the car were drawn along by means of a spring balance and the pounds indicated on the balance were divided by the number of tons weight of the car, it being understood that the clutch of the car was depressed.

The resistance so indicated does not include any friction in the engine, as the clutch is depressed, but it does include the friction in the gearbox and the jack shaft, the friction of the universals, the rear pinion and the large pinion of the differential, the wheel bearings and the resistance to rolling of the rubber tires, and finally the resistance of the air. It assumes a hard, smooth road, no grade and no wind.

Air Resistance and Speed

One rapidly increasing factor as speed increases is that of air resistance. It is a necessary part of the coasting resistance and there is no need to give special attention to it except perhaps to say that it is estimated that the average touring car presents a surface of about 12 sq. ft. to the air

through which it travels, and that the air resistance increases as the cube of the speed.

Stated in terms of horsepower, it may be said that at 15 m.p.h. it is almost negligible. At 40 m.p.h. it consumes about 10 hp. and at 50 m.p.h., 21 hp. and soon thereafter has so increased as to consume practically the whole horsepower of the car.

To illustrate how much of resistance the air may offer, it may be sufficient to refer to the nightly meteors, most of which become so heated in the very rare upper atmosphere of the earth as to be entirely consumed in their passage through it.

By reference to Fig. 1, which is reprinted from the article by Professor Marshall, the coasting resistance will be noted as the lowest curve. It would have been possible to include in the diagram below this a curve of resistance due to the air, and also a curve which might be deemed the theoretical curve of resistance, being a curve toward which it would be the ideal of manufacturers to bring their product.

Referring again to the illustration, it will be noted that certain grade curves are drawn which in each case are exactly parallel to the coasting resistance curve and correspond to increased resistance in pounds at the rate of 20 lb. for each 1 per cent of grade. This means that that number of pounds is added to the coasting resistance on the level when the car is required to mount the given grade.

The four torque curves are drawn to show, for each gear setting, the number of pounds of resistance per ton which the engine is capable of overcoming at the several speeds indicated on the diagram.

For example, in high gear, which on the diagram is denoted fourth speed torque at 15 m.p.h., the capacity of the engine is about 230 lb. per ton. It will be seen that this is far more than sufficient to maintain a speed of 15 m.p.h. on the level and is considerably more than sufficient to enable the car to mount a 5-per-cent grade, but will not quite permit it to mount an 8-per-cent grade. At 20 and 25 m.p.h., the torque curve shows substantially the same ability in number of pounds per ton, which means, in view of the increased speed, actually considerably more engine power, but at the same time, by reference to the diagram, it will appear that a grade which at 15 m.p.h. could be climbed, cannot be climbed at 25 m.p.h. and in fact, at about 37 m.p.h. although there is little diminution in the capacity of the engine to overcome resistance in pounds, there is a crossing of the torque curve with the 5-per-cent grade curve, which shows that the utmost speed of the car on such a grade is 37 m.p.h.

If the diagram were continued ¼ in. farther to the right, to the crossing of the coasting curve with the torque curve, we would arrive at the point where the coasting resistance just equalled the ability of the engine to overcome resistance and the maximum speed of the car, about 55 m.p.h., would thus be indicated.

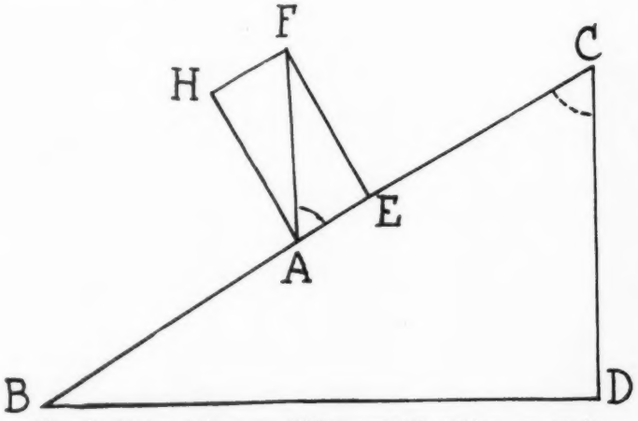


Fig. 2—Forces acting on 2000-lb. weight resting on grade

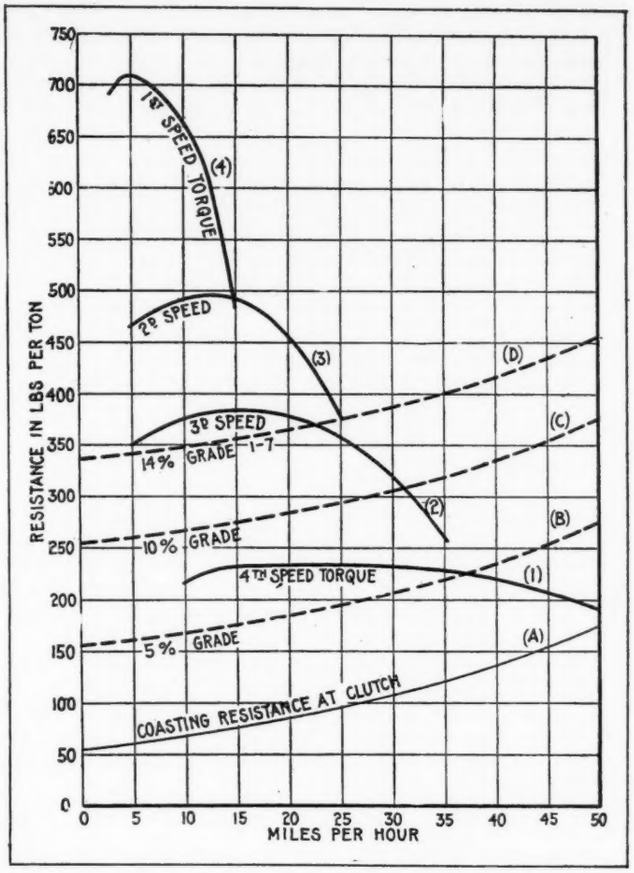


Fig. 1—Relationship of engine torque, gear ratio and grade climbing ability

For low gear, which on the diagram is spoken of as "first speed torque," the increased number of revolutions as compared with the speed of the car enables the engine to overcome a vastly increased number of pounds of resistance running up, at 5 m.p.h., to an excess of 700 lb., and indicating a capacity at that speed to ascend a grade of 35 per cent. As the speed of the car increases, however, the capacity of the engine, as measured by pounds of resistance, rapidly decreases, so that at 10 m.p.h. a 30-per-cent grade would be its greatest capacity and at 15 m.p.h. it would scarcely be able to mount a 20-per-cent grade.

In the second and third gears, the torque curves curve upward from 5 to 15 m.p.h. In other words, the capacity of the engine to overcome pounds of resistance actually increases as the speed increases.

Power and Speed

Of course the increased speed delivers more horsepower but it delivers so much more that the ability of the car to mount higher grades is increased. It is for this reason that on any given grade the car may be able to mount a grade provided it starts at a considerable speed, which grade it could not mount on that gear if starting at a lower speed.

The diagram also indicates that in each case there is a capacity, greater or less, to accelerate on the grade except at the point where the torque curve and the grade curve cross each other, which crossing marks the maximum speed for that car and gear.

While the rolling resistance and the wind resistance and the other items which make up the coasting resistance are more or less matters of experiment and uncertainty, the grade resistance is capable of being stated with mathematical exactness.

In Fig. 2, let the point A represent 2000 lb. of weight resting on the grade $B\,C$. Let $C\,D$ be vertical, $B\,D$ being the horizontal earth surface. Draw $A\,F$ also vertical and of a convenient length to represent the 2000 lb. of weight acted upon by gravity. Then, on the theory of the parallelogram of forces, which in this case will be a rectangle, let $H\,A$ be drawn at right angles to $B\,C$. $A\,E$ will then represent in direction and length the amount of resistance necessary, friction not being considered, to prevent the motion of A down the grade, and $H\,A$ in direction and length will be the pressure of A upon the grade surface. The two triangles $F\,A\,E$ and $B\,C\,D$ will be similar, by reason of the fact that each of them have a right angle and also one of their other angles equal, viz., the angle at C and the angle at A as indicated on the diagram.

We therefore have the proportion:

$$A\,E : C\,D :: A\,F : B\,C$$

$$\text{Therefore } A\,E \times B\,C = C\,D \times A\,F$$

$$A\,E = A\,F \times \frac{C\,D}{B\,C}$$

But $A\,E$ equals the pounds of resistance per ton. $A\,F$ equals 2000 lb., and $C\,D \div B\,C$ is the grade per cent. That is to say the weight of 2000 lb. multiplied by the percentage of grade gives the length of the line $A\,E$, or in other words, the resistance in pounds necessary to prevent motion down grade.

In passing it may be noted that the length of the line $H\,A$ added to the line $A\,E$ makes it evident that between them they account for much more than the 2000 lb. But the fact that $H - A$ is shorter than $A - F$ indicates that the body if in motion does not rest on the incline with its full weight of 2000 lb. This will be the more evident as the slope approaches the perpendicular, the weight on the slope reaching its vanishing point when the slope has become quite up and down.

Incidentally it may be remarked that a 2000-lb. ton lends itself very conveniently for grade calculations, which thereby run 20 lb. to each per cent of grade.

Grade Measured Up the Slope

It is also to be noticed that grade is not measured along the horizontal but up the slope. This is convenient for outdoor purposes but not quite so convenient in consulting contour maps although, for grades used in road work, the difference between the two measurements is comparatively slight.

Closely related to the resistance necessary to prevent motion down the grade is the acceleration which grade produces where the resistance is not met. The word "acceleration" has begun to appear quite frequently in car advertisements and is sometimes used rather vaguely. It is, however, evidently a word to which the public is expected to attach some meaning.

In this connection it will be necessary to recall certain physical facts, which are that, omitting air resistance which does not greatly affect the acceleration at low speed, it is approximately accurate to say that a body dropped from rest will have fallen at the end of 1 sec. 16 ft., but its acquired speed at the end of the next second will be at the rate of 32 ft. per second. This is called its acceleration. If it continues to fall and the air resistance is eliminated, its speed at the end of each successive second would be 32 ft. greater than at the end of the preceding second, while its actual travel will have been at a mean speed equal to the speed at the beginning of the period plus the speed at the end of the period, divided by two, viz.,

Speed at beginning of second period, 32 ft. per second
Speed at end of second period, *i.e.*
$32 + 32$ 64 ft. per second
$32 + 64 = 96 \div 2 = 48$, or mean speed and drop of second period.

The total drop for the 2 sec. would be the mean speed of the first second, viz., 16, plus the mean speed of the second second, viz., 48, a total of 64 ft.

At the end of the third second, the speed would be, as above indicated, *i.e.*

Speed at beginning of third period, 64 ft. per second
Speed at end of third period, *i.e.*
$64 + 32$ 96 ft. per second
$64 + 96 = 160 \div 2 = 80$, or mean speed and drop of third period.

The total drop for the three periods or seconds would be the total of the drop for the first 2 sec., 64 ft., plus the mean speed of the third second, 80 ft., a total drop of 144 ft. for the 3 sec.

If the number of seconds which the body falls is successive, 1, 2, 3, 4 and 5, the increased spaces during each interval will be as 1, 3, 5, 7, 9, respectively, and the total space passed through will be as the square of the number of seconds, viz., 1, 4, 9, 16, 25. If these spaces and the total distance are multipled by 16, the results will be the distances in feet.

The rule is equally true with regard to fractions of a second. If a body starts from rest, in a quarter of a second it will have a speed of 8 ft. per second with a mean speed of 4 ft. per second, and as the interval is but ¼ sec., its actual drop will have been 1 ft. At the end of ½ sec. it will have dropped 3 additional feet, and at the end of ¾ sec. 5 additional feet, and between ¾ sec. and the full second, 7 ft. to a total drop of 16 ft.

It is also a fact that eliminating the question of friction, a body descending a slope will at the foot of it have acquired the same speed as if it had dropped perpendicularly to the lower level. Of course it does not arrive at that point on the slope in the same number of seconds.

Referring again to Fig. 2, if $B - C$ is assumed to be a 5-per-cent grade, it will of course be twenty times longer than the perpendicular $C - D$. Assuming for convenience that $C - D$ is 16 ft. in length, then $B - C$ will be twenty times 16 ft. in length. As in the case of a falling body, the average speed of the body on the grade will be one-half of the acquired speed, and as we have assumed $C - D$ to equal 16 ft., the speed will be at the foot of the grade the rate of 32 ft. per second and the average speed at the rate of 16 ft. per second. In other words, it will have taken 20 sec. to have descended from C to B, and its total acceleration being 32 ft., its acceleration per second for each second of its journey will be 1.6 ft. In other words, the acceleration on the grade per second will be found by taking that percentage of 32 ft. which shall be the grade percentage.

Calculation Is Simple

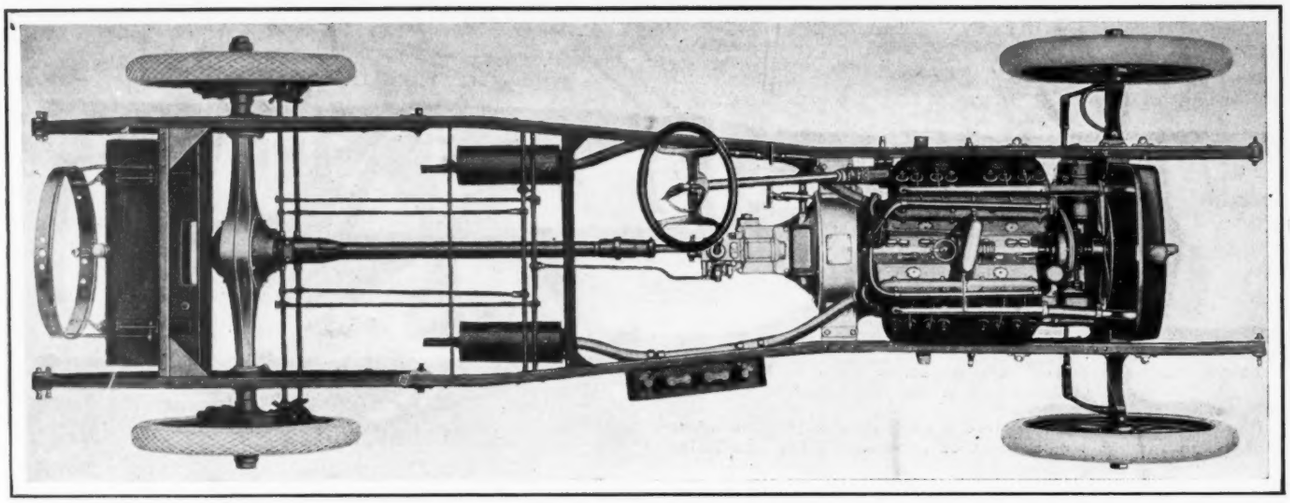
We have, therefore, three expressions relating to grade which are in a sense interchangeable, and any one of them being given, the other two can be calculated easily. If we multiply 32 by the grade percentage we get the acceleration in feet per second. If we multiply 2000 lb. of resistance by the grade per cent, we get the resistance per ton for that grade. And conversely, if we know the resistance per ton, dividing it by twenty will give us the grade per cent, expressed as a whole number instead of a decimal. (Dividing by 2000 will produce the decimal grade, 0.03, or 0.05, or 0.07, which is read 3 or 5 or 7 per cent as the case may be.) If on the other hand one has the figures 1.6 acceleration, dividing by 32 will give the grade per cent.

Or by multiplying by 62.5 the corresponding resistance in pounds per ton will be found. The whole operation in this case is the division of the acceleration by 32, which has the effect of producing the grade per cent, and multiplying that by 2000. The equation then stands:

$$R = \frac{1.6 \times 2000}{32}$$

Cancelling out the 32 against the 2000 produces the 62.5,

(*Continued on page* 17)



Plan view of the Ross eight chassis for 1917, which has a 130-in. wheelbase and uses 34 by 4 tires

Better Body Lines in Ross Eight

1917 Model Shows Practically No Mechanical Changes —Double Cowl a Feature—Chassis Is Strongly Built

FOR 1917, the Ross eight-cylinder car appears in a new dress that is in accord with latest body fashions in every particular. The vehicle is practically the same mechanically as it was when this model was first brought out by the Ross Automobile Co., Detroit, over a year ago, but there have been some important revisions of its lines that make it a very attractive car. However, the price remains unchanged at $1,350.

Equipped with a standard eight-cylinder Herschell-Spillman engine with dimensions of 3¼ by 5 in., it has ample power under all conditions, and, although it is a big car with a wheelbase of 130 in., it is lively and responds readily to the throttle. Ross has taken care of the suspension so that riding is in comfort whether the full quota of seven passengers is being carried or only one or two.

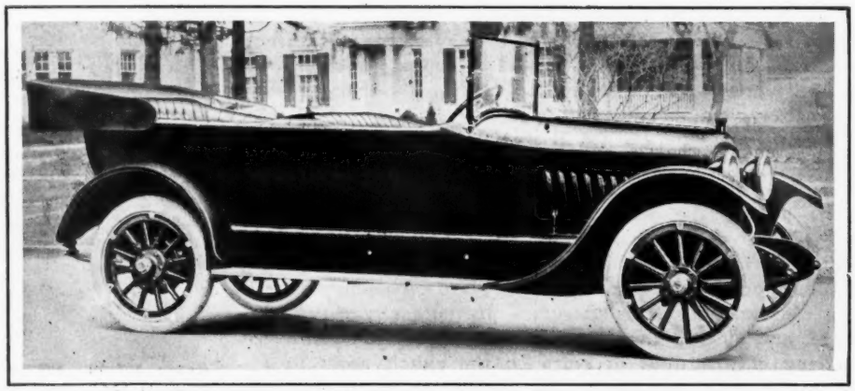
The modern double-cowl effect has been worked out at the back of the front seat, and the hood slopes into the cowl without a break, the radiator shell also sloping to the hood in a very pleasing manner. Doors are wide and fit snugly, and there is enough rake to the steering column to assist in giving the racy appearance so often sought by designers but sometimes not attained.

Stripped of its new body, the chassis presents a most substantial look, with a tapered frame of deep section, sturdy drive members and long and wide springs. In unit with the motor are the clutch and gearset, and the driveshaft is inclosed within an efficient torsion tube. The specifications include a multiple-disk clutch, floating rear axle, semi-elliptic springs all around, rear gasoline tank with Stewart vacuum feed, Zenith carbureter, Ward Leonard two-unit starting and lighting system and 34 by 4 tires.

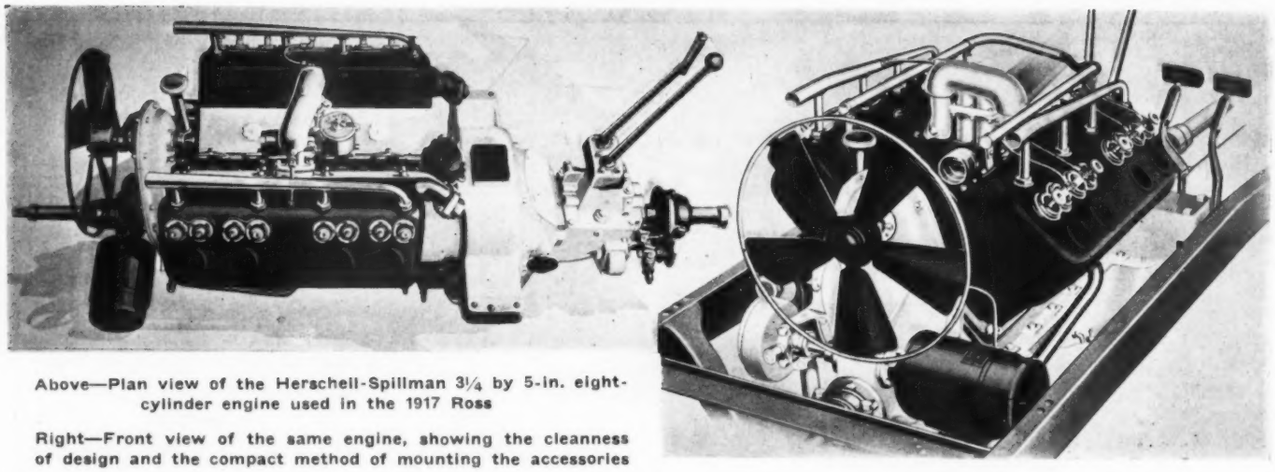
Turning to the most important unit, the engine, it is at once noted that no alteration has been made in the standard Herschell-Spillman design. The cylinder dimensions give a rated power of 33.84 hp., with a displacement of 331.8 cu. in., but the motor is capable of delivering upward of 75 hp. on the block, an evidence of the fact that there is plenty of power under the Ross hood to take care of the car under all conditions.

Inasmuch as this engine has been described on several occasions, it is not necessary to go into very great detail. The photographs indicate the general arrangement, with the two blocks of cylinders at 90 deg. and staggered to allow the two opposite connecting-rods to be mounted side-by-side on the common crank bearing. The valves are made reasonably accessible by the disposition of the parts that of necessity have to be in the V between the cylinder blocks, the carbureter being so mounted that it is little in the way, and the exhaust manifolds being well above the valve compartments. Although the ignition distributer is mounted vertically at the extreme rear of the cylinders, it is really not in the V, and so the carbureter is practically the only obstruction.

Conventional practice holds throughout the internal construction of the motor, there being a sturdy crankshaft, directly above which is mounted the single camshaft that actuates both sets of valves through rockers that are hinged to the top of the crankcase. At the front there is a cross shaft that is connected to the crankshaft by a worm gear and on



The Ross eight-cylinder seven-passenger touring car for 1917 which sells for $1,350



Above—Plan view of the Herschell-Spillman 3¼ by 5-in. eight-cylinder engine used in the 1917 Ross

Right—Front view of the same engine, showing the cleanness of design and the compact method of mounting the accessories

its right end this shaft drives the double water pump, while the left end connects to the generator armature. This cross shaft drive is inclosed by the same plate that houses the spiral gears, driving the camshaft and the fan shaft above this latter. Thus a very compact front end is obtained with not even an exposed fan drive. The drive of the vertical ignition distributer is through bevel connection with the camshaft at its rear end.

On the right rear side of the engine is carried the starting motor, this connecting automatically with the flywheel teeth by means of the Bendix drive unit, whereby, when the current is switched to the starting motor through the starter pedal, the rotating of the armature shaft automatically throws the pinion gear into mesh with the flywheel. After the engine picks up and rotates faster than the armature shaft, the pinion is again automatically thrown out of mesh.

No Exposed Mechanism

As the flywheel is inclosed, there is practically no exposed operating mechanism in this power plant, a feature that is commendable from a mechanical and maintenance standpoint, although it adds slightly to the weight.

Lubrication is given special attention, as it is an important part of the proper operation of an eight. There is no splash to it; distribution to the various bearing surfaces is entirely by pressure maintained by a regulating valve between a minimum of 10 lb. per sq. in. and a maximum of 40 lb. per sq. in. The gear pump is located in the crankcase well on the bottom of a vertical shaft which takes its drive through spiral gear connection with the camshaft. Oil is delivered through a longitudinal tunnel running the length of the crankcase, and from this by individual branches to the three main bearings of the crankshaft and the three camshaft bearings. The crank webs are drilled, and the oil is thus led by centrifugal force to the lower rod bearings, from which it is piped through steel tubes to the wristpin bearings, these tubes attached to the rods. An overflow valve allows the excess over the requirements of these bearing surfaces to be delivered to the front gears, keeping the gear assembly submerged well above the cross shaft.

Ross is using the Borg & Beck clutch, which is the type in which there is only one plate, this running dry between two wire-woven asbestos plates, and by a series of levers the force holding the plate in engagement is stepped up to a very large amount without the use of an extraordinarily heavy spring. A 200-lb. spring is sufficient to produce a pressure of 2500 lb. at the point of plate engagement, due to the construction. This therefore prevents any clutch slippage, and at the same time the unit is easy to operate, requiring only a light pressure on the clutch pedal to disengage it. In connection with the clutch mechanism, the pedal is adjustable for position, due to the use of a flange drilled with several holes and attaching to a flange on the pedal in a number of different positions wherever any set of holes in the two flanges will register.

A Grant-Lees gearset is also incorporated with the engine, this being a very compact unit affording the usual three speeds and reverse. The gears and shafts in this unit are constructed of chrome-nickel steel, and the gears have wide faces with stubby teeth for strength. Just back of the gearcase is the speedometer drive gearing, and then a universal joint, after which the propeller shaft enters a torsion tube that is in unit with the rear axle. The front end of the tube is supported in and slides in an arm that hinges to the bottom of the gearbox.

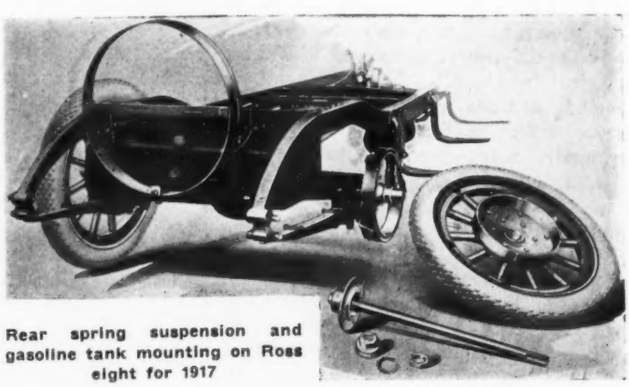
Rear Springs Slung Under Axle

Both axles are manufactured by the American Gear Co., and follow standard lines. The rear unit has a pressed-steel housing that is webbed outside at top and bottom as a strengthening factor, and the springs are underslung from it. The gear ratio is slightly lower than 4 to 1 in order to give the engine plenty of consideration. This ratio is such that the car affords excellent accelerative possibilities.

Now quite familiar is the semi-elliptic form of spring suspension at the rear. In the Ross adaptation, the springs have a length of 57 in., and due to the generous bend down of the rear of the frame, they are normally nearly flat, even though they do pass below the axle. This allows them to work efficiently to dampen road shacks and to promote easy riding as well as being better for them.

Hung from the rear cross member of the frame is a large gasoline tank, so positioned that it is practically balanced on its mounting, preventing any bending strains being set up.

Nothing has been forgotten in the equipment of the new Ross, the list of articles including a motor-driven horn, one-man top, Stewart speedometer, ammeter, demountable rims and the usual complement of tools.



Rear spring suspension and gasoline tank mounting on Ross eight for 1917

Motor Trucks Aid Army in Mexico

First Official Photographs Taken Below Border of Motor Truck Equipment of Punitive Expedition in Action on Villa Pursuit

Photographs by Underwood & Underwood

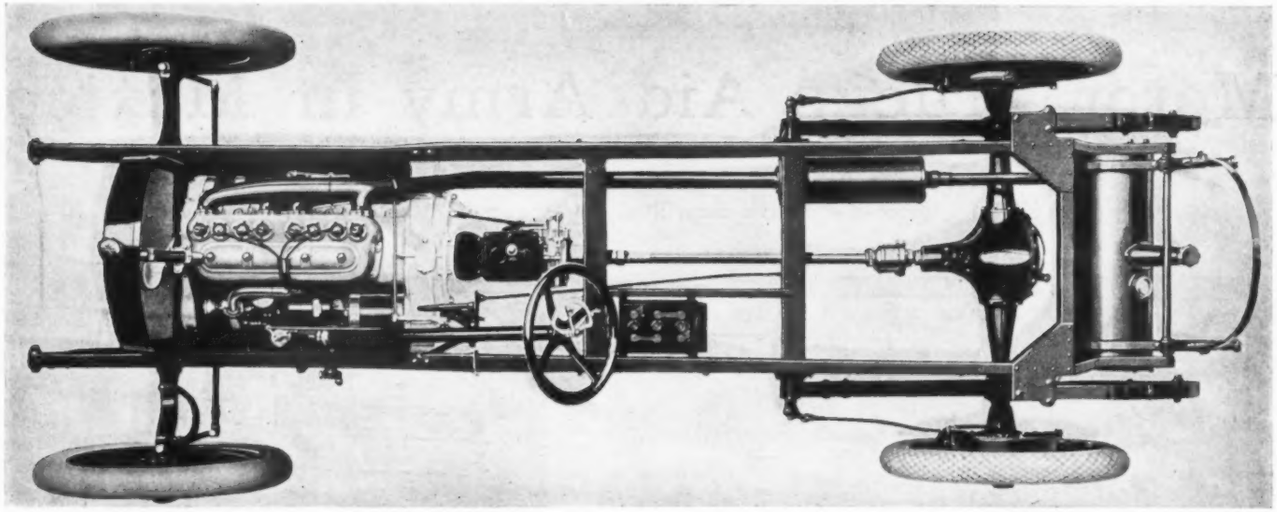
1—*Section of White trucks with the Pershing expeditionary forces arriving at Boca Grande, Mexico.*

2—*Armored car which Cap. Wm. H. Forrest, of the Eighth Machine Gun Company, Massachusetts National Guard, is driving across the continent in a preparedness campaign.*

3—*Motor trucks with troops and rations bound for San Antonio, Mexican base of the expeditionary forces in pursuit of Villa. This photograph was taken near Namiquipa, Mexico.*

4—*Packard army trucks making good time on a road through the low sand dunes of northern Mexico.*

5—*An excellent view of the latest Mack armored car built for the New York National Guard.*



Chassis of the Jeffery Roll-Edge Four for 1917, showing the mounting of the 3¾ by 5¼ block engine, three-speed selective gearset, etc. It is stated that 93 per cent of the parts used in this car are manufactured in the Jeffery plant

New Body Feature of Jeffery Four

No Chassis Changes in 1917 Model Which Is Called Roll-Edge Four—Price $95 Higher—Body Lines Unbroken from Front to Rear — New Cellular Radiator Used

FOR 1917 the Jeffery four is continued with no changes in the chassis, a price increase of $95, the new car selling for $1,095, and a new body which gives the car the trade name of the Roll-Edge Four. A new cellular radiator is the only other change.

Body Lines Unbroken

The roll-edge four comes upon the demand of Jeffery dealers who have been insistent since the six was announced last January with a roll-edge body, that the four be furnished them in the same style, according to the announcement of the factory.

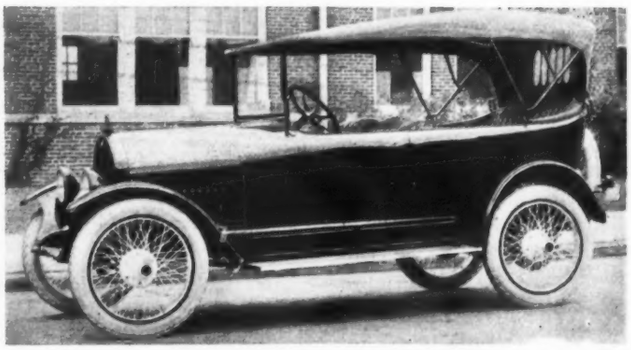
A particularly noteworthy feature of this new Jeffery body is its unbroken lines from the radiator to the rear seat and between fenders. The roll edge on the top of the body blends into the hood without any break whatever from the straight line effect, making the car look exceptionally long and clean. The divided front seat feature which was a part of the 1916 body design is continued without change.

93 per Cent of Car Jeffery-Built

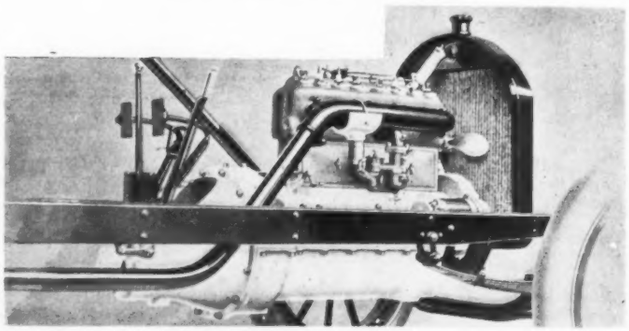
The new four has a 3¾ by 5¼ in. block engine, disk clutch, three-speed gearset, and semi-floating axle. The wheelbase is 116 in. and the tires are 34 by 4. Practically every part of the car is Jeffery built, in fact the manufacturers state that 93 per cent of the machine is constructed in the Jeffery factories.

Comfort an Important Consideration

The new bodies are finished in Savoy green with a fine gold stripe, fenders and running gear black, and the wheels green with a gold line. Upholstery is in black leather with deep double-deck springs. Auxiliary seats which disappear in the back of the front seats are standard equipment on all models. Inasmuch as the rear seat is 48½ in. wide the car provides for seven passengers very comfortably.



Side view of the Jeffery Roll-Edge Four for 1917, showing the unbroken body lines and the feature which gives the car its name. Wheelbase is 116 in. and tires are 34 by 4. The car sells for $1,095 with complete equipment



Three-quarters rear view of the four-cylinder, 3¾ by 5¼-in. block engine used in the new Jeffery Roll-Edge Four, showing the control levers mounted directly on the gearbox. Note the rake of the steering column

Rate Tractors by Drawbar

Present Horsepower Rating Misleading to Farmers—Rating Should be U. S. Standard

By Raymond Olney*

ONE of the greatest needs in one of the greatest fields in agricultural engineering is that of a standard basis for rating farm tractors.

The present method, which any engineer must admit is unsuited to the purpose, is to rate the drawbar capacity of a tractor at about one-half the brake or belt-power rating of the engine. This is a relic of the early days of the gas tractor industry. But worse than that, it gives the farm buyer no definite idea as to the actual pulling capacity of a tractor. Such a method is not only unsatisfactory; it is misleading.

The engine rating should be in terms of horsepower; I believe all engineers are agreed on that point. But the drawbar rating is another matter.

The term "horsepower" is one that is easily misunderstood by the average farmer, especially so when it is applied to drawbar power. His knowledge of mechanics being limited, he ordinarily thinks of a tractor rated at so many drawbar horsepower as the equal in pulling ability of that number of horses, which, of course, is not true.

In his experiments on the draft of horses, F. H. King found that about the maximum walking draft of a horse is one-half its own weight; and pulling with this intensity at a speed of 2½ m.p.h., the power developed by a 1200-lb. horse would be 4 mechanical horsepower. For steady and continuous work 10 hr. a day, at the same speed, it is commonly allowed that the horse should not be called upon to pull more than one-tenth his own weight; at this rate a 1200-lb. horse would develop 4/5 hp. The average farm horse, particularly for heavy work, will not travel as fast as 2½ m.p.h., and will probably develop at the slower speed an average of not more than 2/3 hp.

Why Rating Is Misleading

Assuming a 25 per cent overload, your tractor capable of 12 drawbar horsepower will develop 15 hp. as its maximum load. On the basis of a maximum walking draft, as recorded by King, a four-horse team will also develop 15 hp., but only for short distances, of course. Now if a farmer gets a 12-hp. tractor into a tight place and finds that it will then pull no more than a four-horse team, he is quite apt to wonder what is wrong, and the cause of his wonder is the confusion resulting from our method of rating.

This is not the most important reason, however, why the rating should not be given in terms of horsepower.

Suppose the man who wants a tractor visits one of our public power-farming demonstrations, where he sees machines of nearly every make and size demonstrating their ability to pull plows. Here we will say he finds three different tractors, each pulling a gang of four plows, which we will assume is the normal full-load capacity of each. One may be rated at 12 hp., another at 15 hp., and another at 18 hp., but each pulling the same number of bottoms. This is no puzzle to the engineer, but it is to the farmer; it is decidedly confusing to him, because he is not familiar with the relation of speed to power.

Again he may see two tractors plowing within a few yards of each other, each with a drawbar rating of 12 hp., but one pulling three plows and the other four. In this case, as in the former, the engineer would readily appreciate that the factor of tractive speed accounts for these differences, but the farmer might not.

The greatest objection, as I see it, to the present method of rating is that it gives the prospective purchaser no understandable means of comparing at once the actual pulling ability of the different makes and sizes of tractors.

There is a tendency at the present time to rate the pulling capacity of tractors according to the number of plows they will haul under average soil conditions, say, a two, three or four-plow machine. But this method is equally as unsatisfactory as the one now in use, for the reason that the terms "average soil conditions" means something different for different kinds of soil. The draft of plows not only varies widely in different kinds of soil but in the same soils under different conditions.

I am convinced that the only logical method of rating the pulling ability of tractors is in pounds. Tractor engineers have already discussed this subject to some extent and this method seems to be gaining some support. A tractor concern which has taken the lead in this direction, makes the following statement in its catalog as to why it favors a pounds-pull rating:

"We rate the power of our tractors in actual pounds pull developed at the drawbar, because the wide difference in ratings of identical size motors given by various manufacturers, and the variation of mechanical efficiency of different tractors, makes a horsepower rating of little real value to the purchaser in determining just what any tractor with merely a horsepower rating will pull."

I will show graphically why it is more logical, as well as scientific, to rate the pulling capacity of a tractor in pounds pull instead of in terms of horsepower. The two sets of curves shown illustrate my contention very clearly. The curves of "engine torque" and "brake horsepower" were reproduced from the data obtained from an actual Prony brake test on a 3½ by 5¼ tractor engine of the four-cylinder, heavy-duty type.

Two facts of prime importance are brought out by the curves: 1—The torque is practically constant throughout a wide range of engine speeds; this is characteristic of gas

TABLE OF ENGINE AND TRACTOR DATA

R. P. M	Brake H. P.	Torque In.-Lb.	Drawbar Pull-Lb.	Drawbar H. P.	Speed M. P. H
400	8	1260	2010	535	1
600	13	1370	2250	900	1½
800	18	1420	2360	12.60	2
1000	22.5	1420	2360	15.75	2½
1200	27	1420	2360	18.90	3
1400	31.5	1415	2340	21.80	3½
1600	34.5	1360	2220	23.70	4
1800	36	1260	2010	24.20	4½

Size of Engine—3½ x 5¼; gear ratio, 84 to 1; transmission efficiency, 85 per cent.; rolling resistance, 16 per cent.; drive wheel diameter, 70½ in.; weight of tractor, 4500 lb.

*Paper read at N. G. E. A. convention in Chicago, June, 1916.

power motors; 2—The brake horsepower varies directly as the speed up to a certain point.

For the purpose of illustration I will suppose that this engine is installed in a tractor, for which I will assume a gear ratio of 84 to 1, a transmission efficiency of 85 per cent, a drivewheel diameter of 70½ in., and a total weight of 4500 lb. My object is to calculate the drawbar pull.

The torque of the engine and the gear ratio determine the pulling ability of a tractor. The pounds pull at the drawbar is the product of the engine torque, gear ratio and transmission efficiency divided by the radius of the drivewheel, less the tractive resistance, which I will assume is 15 per cent in this case. This gives me the column "drawbar pull" (in the table), and from this is plotted the curve of "drawbar pull," which, of course, is similar to the torque curve since drawbar pull varies directly as the torque of the engine.

The drawbar horsepower is the product of the pounds pull and the tractive speed divided by a constant, and varies directly as the speed.

By referring to the "drawbar horsepower" curve, it is evident at once that we might give our tractor a drawbar rating of from 8 to 20 hp., depending upon the speed of the motor and assuming that the gear ratio remains unchanged. And herein lies the chief objection to a rating in terms of horsepower.

On the other hand, the engine torque, and likewise the pounds drawbar pull, remain practically constant throughout a wide range of speed, so long as the gear ratio does not change. Between a motor speed of 800 and 1400 r.p.m., or a corresponding tractive speed of 2 and 3½ m.p.h., as shown by both curves and table, the pounds pull at the drawbar is practically constant. Also between tractive speeds of 1¾ and 4 m.p.h., which represents the extreme limits of working speeds of tractors, the variation in pounds pull at the drawbar is exceedingly small.

The farmer is not so much interested in the amount of horsepower that a tractor is supposed to develop at the drawbar; he is more concerned with the actual pulling force it is capable of exerting on a plow or other implement. If the drawbar rating of your machine is in pounds pull, you are giving him something tangible, and throughout a fairly wide range of engine speeds this pull will remain practically constant. There is no confusion in his mind as to the tractor's actual drawbar capacity.

In case this method of rating is adopted as standard, as no doubt it will be sooner or later, it will be essential to have the tests on which the different ratings are based carried on under some sort of official supervision. Equipped as it is with its fine corps of trained experts and the excellent facilities at its disposal, it is a wonder to me that the United States Department of Agriculture did not long ago see the vital need of a standard rating for farm tractors, to the extent of taking some action in this direction. It is only within the past few months that the department seems to have taken the problem seriously.

In the first place, provided the manufacturers adopt the plan that is being worked out, it is my opinion that the U. S. D. A rating should include an engine as well as a drawbar rating. A Prony brake test should be made to obtain data for determining the torque and brake horsepower at various speeds. The torque curve of any engine, like the one shown here, will indicate the normal or critical speed, or the speed at which the engine produces the greatest torque. The brake horsepower rating should be given on the basis of the torque at this speed.

The basis for the drawbar rating should be the pounds pull exerted in an actual pulling test. The drawbar test should be made with the engine running at its critical speed and with the tractor traveling at its best working speed as fixed by the gear ratio.

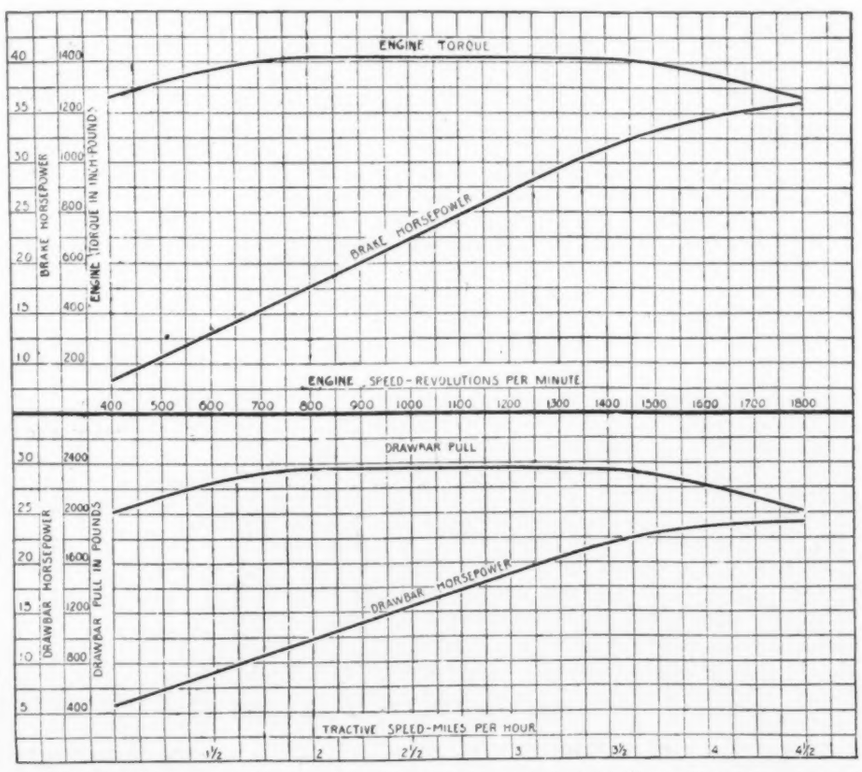
Just what equipment, conditions, etc., should be standardized for conducting such tests is a big problem in itself and I will touch on it only briefly.

Personally, I am of the opinion that, for all practical purposes, it would be sufficient to have tests for establishing drawbar ratings made on hard, level ground, such as a good, dragged dirt road, where slippage for most tractors would be practically negligible. The necessary data could be obtained by means of a recording traction dynamometer such as the one developed and perfected by the Hyatt Roller Bearing Co., with which the majority of tractor manufacturers are already familiar.

Draft Tests on Dirt Road Easiest

While draft tests conducted on a dirt road would show a higher drawbar pull than a tractor would be capable of delivering in a sod, stubble or plowed field, it would be a much less difficult problem to secure standard conditions of footing there than in a field where ground conditions may be extremely variable.

A method of indicating a tractor's rating, that has already been suggested, is by means of a double figure, as is the present practice, but to use pounds pull instead of the drawbar horsepower; as 1500-20 instead of 10-20, or 2000-25 in place of 12-25, the first figure in the combination representing the pounds pull and the second the brake horsepower. With this rating should also be included the tractive speed at which the machine will operate best under load.

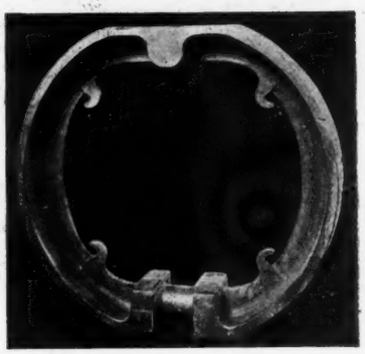


Curves based on results of Prony brake test of four-cylinder 3½ by 5¼-in. tractor engine, illustrating advantages of rating pulling capacity of tractors by pounds pull

Aluminum Engines Coming in France

Peugeot and Panhard Make Aluminum Engines Without Cylinder Liners — Aluminum Brake Shoes Popular

By W. F. Bradley



Aluminum brake shoes for Peugeot truck

THE general adoption of the aluminum piston, which has been such a remarkable feature of the American automobile industry, has had no counterpart in Europe. This is all the more surprising when it is remembered that the initial experimental work was done in France and Germany, and that the Cothias process of aluminum die casting—known in America as the Lynite—was extensively employed in France as far back as 1897 for a variety of small mechanical parts.

Six or seven years ago, when the question of motor efficiency was beginning to receive close attention, experiments were made with aluminum pistons by practically all European firms. At that time, however, certain details remained to be perfected and, after tests which were not completely satisfactory, the factories one by one decided that aluminum was not practicable for pistons. Where light reciprocating parts were required, steel pistons were used, and for racing purposes steel pistons machined from the solid billet were the invariable equipment. The only French firm having changed unhesitatingly for the aluminum piston is the Chenard & Walcker company, which has used it on all its stock motors for the last 4 or 5 years. The general public, however, is not aware of this fact; and so small is the amount of publicity concerning aluminum pistons that it probably would have done the firm more harm than good to state that they had departed from the ordinary methods.

Panhard & Levassor's Work

For the last two or three years the Panhard & Levassor company has made use of aluminum pistons on a little 10-12-hp. poppet valve model of 2¾ by 5½-in. bore and stroke. This is a very successful and very popular model, but even dealers generally are not aware that they have been selling a car with aluminum pistons.

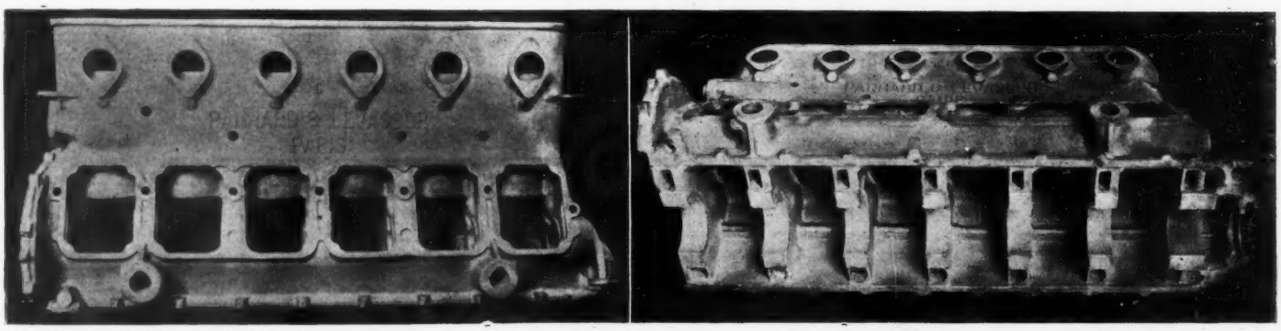
The D. F. P. company has made a practice of fitting its sporting models with aluminum alloy pistons, again without informing the public of this fact.

In Italy the general situation has been similar to that of France. All the Italian factories experimented with aluminum alloy pistons, but with the exception of the comparatively little-known Chiribiri company of Turin, not one firm adopted them for stock models. The Aquila-Italiana company did much experimenting, but does not appear to have been decided about the complete adoption of aluminum alloy pistons. The Fiat company, which maintains its own aluminum foundry, is also much interested in this question. It has used aluminum alloy pistons on its racing cars, particularly on the three machines which ran in the last French Grand Prix at Lyons. These cars had engine trouble, but the pistons stood up in a very satisfactory manner. Aluminum alloy pistons are also employed exclusively on Fiat aviation motors—and this firm is the biggest aviation motor producer in Italy. For stock models the firm appears to be hesitating. For some of the latest models experimental cars were given hard running on the road for a full year in order to get a definite opinion as to the value of aluminum, without, however, so far as can be learned, a decisive result being arrived at.

Steel Reigned for Years

No important European races have been won with aluminum pistons. Peugeot, who during the last 5 years has done more racing than any half dozen firms combined, has invariably employed steel pistons and been fully satisfied with them. The same applies to Delage. Sunbeam, until quite recently, has been satisfied with steel pistons machined out of the solid. At the annual Monaco motor boat races, where much experimental work was seen, the steel piston was supreme.

Since the outbreak of the war, with the requirement of large numbers of high-efficiency aviation motors, manufacturers have been led to reconsider the claims of aluminum pistons and in many cases have taken up the type of piston



Left—Exhaust side of Panhard & Levassor sleeve-valve motor with cylinders and crankcase cast in aluminum alloy. Right—Interior view of Panhard & Levassor sleeve-valve motor with 5¼-in. bore. Cylinders and crankcase are cast in aluminum alloy by the Cothias method. This process has been used in France for casting numerous small aluminum mechanical parts since 1897

Left—Intake side of Peugeot four-cylinder, sixteen-valve racing type motor cast in aluminum alloy. Cylinder liners and separate valve seats are still to be installed. Right—Exhaust side of Peugeot racing motor casting

they cast aside 6 or 7 years ago. Quite recently the Le Rhone aviation engine company—now combined with the Gnome—produced a new engine from which 120 hp. was obtained. The result was not considered satisfactory and the cast-iron pistons were changed for Cothias die-cast aluminum alloy pistons, when the power was increased to 150 hp., no other changes being made.

As a result, the whole of this series will have aluminum alloy pistons and many of the Gnome engines, with steel cylinders, will also be fitted in the same way.

The Lorraine-Dietrich Co. has had a similar experience. After using cast-iron pistons in an eight steel cylinder water-cooled aviation engine, they got better results with aluminum and completely adopted Cothias die-cast pistons. These pistons are deeply ribbed from the head to the skirt. The Cothias pistons are known in America as Lynite, the Cothias rights having been acquired by the Aluminum Castings Co. of Cleveland.

Peugeot and Hispano-Suiza Interested

Among other firms now making use of aluminum alloy pistons, either completely or partially, are Peugeot and Hispano-Suiza. It is certain that the outcome of present aviation experience will be an extensive adoption of aluminum pistons for car motors. Not a few firms have been experimenting in this direction while the war is in progress, but without making known their results. It is certain, however, that firms will not be rushed into the adoption of aluminum alloy pistons. One factory ran a set of pistons 60,000 miles without dismounting before being convinced. Another put three cars on the road and ran them 12 hr. a day for a full year in order to be sure that the change from iron to aluminum was a wise policy.

Aluminum cylinders also have come to the front during the war period. There is no stock car on the European market fitted with aluminum alloy cylinders, but it would appear that the first commercial adoption of this type of cylinder was made by the Hispano-Suiza Co. of Paris and Barcelona. Engineer Birkigt, of this company, 2 years ago produced an eight-cylinder V engine with each set of four cylinders forming a single aluminum alloy casting, into which thin steel liners were screwed. The head was detachable and of cast iron, and it carried the vertical valves operated by an overhead camshaft. Several patents have been obtained covering the methods of constructing this motor, particularly the system of screwing the liners into the aluminum cylinders and the valve-operating mechanism. The aluminum cylinders are enameled inside and out to guard against any possible porosity of the metal, and the final finish of the outside of the cylinder is a fine black enamel. This motor has been produced in series for a full year and has been most successful. Before its construction was decided on in big quantities it went through 50 hr. full load official brake test. The weight of this motor is 2.4 lb. per hp. without water or oil. Its consumption of gasoline and lubricating oil is very moderate.

The Panhard & Levassor Co. has been running an aluminum cylinder engine, driving factory machinery, for 22½ hr. a day, 7 days a week, for a full year. This engine has no cylinder liners, but the valve seats and head are of cast iron. Although this motor ran constantly for 365 consecutive days, with the exception of the 1½ hr. each day the factory was shut down for meals, no troubles have developed.

The same firm has had on the road during the past year a number of cars with Knight engines, 4⅛ by 5½-in. bore and stroke, fitted with aluminum alloy cylinders without liners. These cylinder castings weigh 46 lb., but in iron the weight is 115 lb. One of the most interesting examples is a big six-cylinder block Knight engine with cylinders and upper half of crankcase forming one casting of aluminum alloy. This with a bore of approximately 5¼ in., has sleeves operating direct on the aluminum walls, and weighs only 202 lb. rough from the foundry. Completely machined, the weight is reduced to 145 lb. A similar casting in iron weighs 510 lb., rough from the foundry, and 375 lb. completely machined. Several of these big motors are in service, with good results so far.

The Peugeot Racing Motor

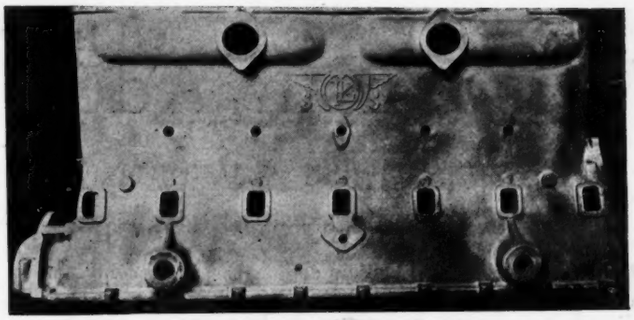
Another important aluminum cylinder engine is a four-cylinder, sixteen-valve Peugeot racing type, shown in one of the illustrations. This has neither cylinder liners nor separate valve seats. In its general design it is exactly similar to the racing engines used by Peugeot on the 1914 Grand Prix cars now in America. The casting shown in the illustration weighs 63 lb. in the rough—that is, before any machining has been done. The cylinders are approximately 2.7-in. bore. The same rough casting in iron weighs 170 lb. On an eight-cylinder engine there is a saving of about 200 lb. by the use of aluminum alloy in place of cast-iron cylinders. These engines are a high-efficiency type running normally at 2800 r.p.m. and several of them are in service.

Another aluminum cylinder engine is a twelve-cylinder horizontal with cylinders cast in groups of six, pistons and valves operating direct on the aluminum. Another make is a six-cylinder vertical with superimposed valves in the head, also without cylinder liners or separate valve seats. It is obvious that the use of aluminum cylinders for cylinder castings is of the greatest importance to aviation engine manufacturers. By this means only has it been possible to get the

weight of fixed cylinder engines down to the low figure of such engines as the Gnome, which are practically all steel, machined out of the solid. The V-type aluminum cylinder costs considerably less to produce than the rotary Gnome type, and is much easier to assemble and keep in condition; while the two types are about equal in weight on the scales, the V engine has a decided advantage when account is taken of gasoline and oil required for a long period of running.

European firms are studying after-the-war models while fighting is in progress. It is too early to say what these models will be like, but it is practically certain that aluminum alloy will replace cast iron for the cylinders of the bigger touring car engines. What may be expected is the appearance first of Knight engines with aluminum alloy cylinders, followed later by poppet valve engines in the same metal.

A development which does not appear to have received the same amount of attention in America as in Europe is the use of aluminum for brake shoes. These are very common on both trucks and touring cars made by the leading French makers. With the tendency toward unit construction of engine and gearbox, both brakes have to go on the rear wheels. European ideas will not admit of internal and external brakes on even the cheaper classes of car, thus the shoes are placed side by side within big diameter drums. Here the use of aluminum enables an appreciable saving of weight to be effected. Panhard-Levassor cars are a good example of this; the rear axle of all this firm's models has an aluminum differential housing, and the big diameter brake shoes are aluminum die castings. Peugeot is another firm making use of aluminum shoes on both touring cars and trucks. Naturally these shoes are lined with asbestos fabric or similar material.



Panhard & Levassor Knight type motor of about 5¼-in. bore with cylinders and crankcase in aluminum alloy

Simple Tests Show Car Condition

(*Continued from page* 8)

which is conveniently known as a constant of gravitation.

If one has found by experiment the resistance at a given speed, and thereafter by a second experiment has found the acceleration in feet per second, he is enabled to find the point on the torque curve at the speed mentioned by multiplying the acceleration in feet per second by the constant 62.5, which gives him the additional capacity of the engine necessary to overcome resistance in pounds per ton, which result is added to the known pounds of coasting resistance, the total indicating the proper location of the torque curve point.

Referring again to Fig. 1, it is evident that if a car is running on the level and at a speed which shows the resistance curve considerably below the torque curve, the opening of the throttle will produce acceleration and the opening of it wide will produce the energy necessary to overcome the number of pounds of resistance per ton which are measured between the coasting resistance curve and the torque curve. It should be remembered, however, that at once the speed of the car will begin to increase and immediately the acceleration will fall off. Otherwise, the speed increases indefinitely.

This does not, however, interfere with the accuracy of the acceleration indication because the definition of acceleration does not require that the force should act through a complete second, but merely that when the force begins to act it shall have the capacity indicated if its action continues through a complete second.

In several of Professor Marshall's diagrams the difference was made evident, by means of curves, between cutting off the ignition, declutching, and bringing the gearshift into neutral, these three being the three ways of cutting off the engine power and coasting.

The usual effect, as shown by him and illustrated by the curves plotted from experiments, showed that the least resistance to coasting was produced when the engine was left running and the gear shifted to neutral, the explanation of this being that the running of the engine took care of the friction in the jackshaft which otherwise had to be absorbed in the coasting resistance, and of course the greatest resistance to coasting was produced by merely cutting off the ignition, for in that case the resistance of the engine, both by compression and friction, had to be overcome in addition to the ordinary resistances.

The distance between each of these curves, measured on the upright lines showing pounds of resistance, indicated the engine friction in one case and the friction in the jackshaft in the other case.

For most purposes there would seem to be no necessity for converting resistance and speed into horsepower, but Professor Marshall exhibited a number of figures showing horsepower, comparing several cars with each other.

The horsepower formula assumes the value of 33,000 lb. lifted 1 ft. in 1 min. as the unit of horsepower. A car traveling 1 m.p.h. covers 88 ft. in 1 min., and 88 ft. divided into 33,000 lb. gives as a quotient 375. The utilized horsepower of any given car then is equal to resistance in pounds per ton, multiplied by the number of tons weight of car and passengers, multiplied by the number of miles per hour and the whole divided by 375. It will be seen, therefore, that, by taking the necessary time for the calculation, a diagram may be produced in which instead of resistance in pounds per ton, the horizontal lines shall represent either horsepower capacity or horsepower expended. The horsepower so exhibited would be the brake horsepower. It is, however, usual, as Professor Marshall points out, to consider that there is a loss at the rim of some 23 per cent of horsepower generated by the engine, so that, having determined the actual brake horsepower by plotting the curve which shall show 23 per cent additional horsepower, one will arrive at the horsepower delivered at the clutch.

The most obvious difference between a horsepower curve and a resistance curve is that the effect of multiplying resistance by speed, in producing the horsepower curve, is to cause the curve to sweep more rapidly upward so that in comparing the curves of two cars a difference which might seem slight in a resistance curve becomes more pronounced when the horsepower curves are examined.

As a matter of general interest, it may be mentioned that a car coasting down a given grade will, if permitted, reach a maximum speed which it will not exceed, that speed being the point where the coasting resistance curve intersects the resistance due to grade. For example, a 5-per-cent grade corresponds to 100 lb. of resistance. If the coasting curve indicates a resistance of 100 lb. at 20 m.p.h., the car cannot exceed 20 miles on that grade.

Wisconsin Adds Aviation Engine

Aluminum Cylinders With Hardened Steel Liners—Many Features Like Racing Engine—Detail Highly Ingenious

IN designing their aviation engine the Wisconsin Motor Mfg. Co. of Milwaukee, Wis., have adhered very closely to the general principle of their racing automobile engines. That is to say, the overhead valves are operated by an overhead camshaft with rocker arms and many of the details are arranged the same way. The aviation motors, however, are much larger, having a bore of 5 in. and a stroke of 6½ in., they being intended for coupling direct to the propeller which mounts on the end of the crankshaft. There is still much argument among aeronautic engineers regarding the relative advantages and disadvantages of direct-driven and gear propellers. The Wisconsin company have chosen to make an engine developing maximum power at a moderate speed, believing that they can thereby obtain the greatest dependability. At present two models are being made, one with six and the other with twelve cylinders, the dimensions being the same.

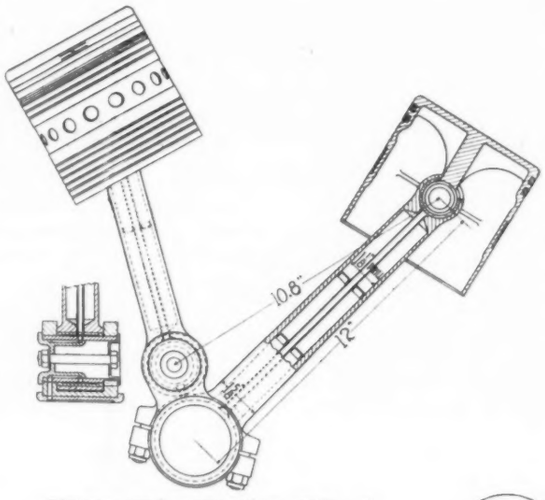
Aluminum Used Extensively

Aluminum enters very largely into the construction of these engines, the cylinder castings for which were illustrated in THE AUTOMOBILE last fall. For the valve seats cast-iron rings are machined and copper plated. They are then heated and placed in position on the core before the casting is made. Cylinders which have been cut up show that the copper makes an intimate connection between the aluminum and iron; in fact if the cylinder is cut in two across the diameter of the valve seat it is only possible to remove the half circle of iron by applying considerable force with a hammer.

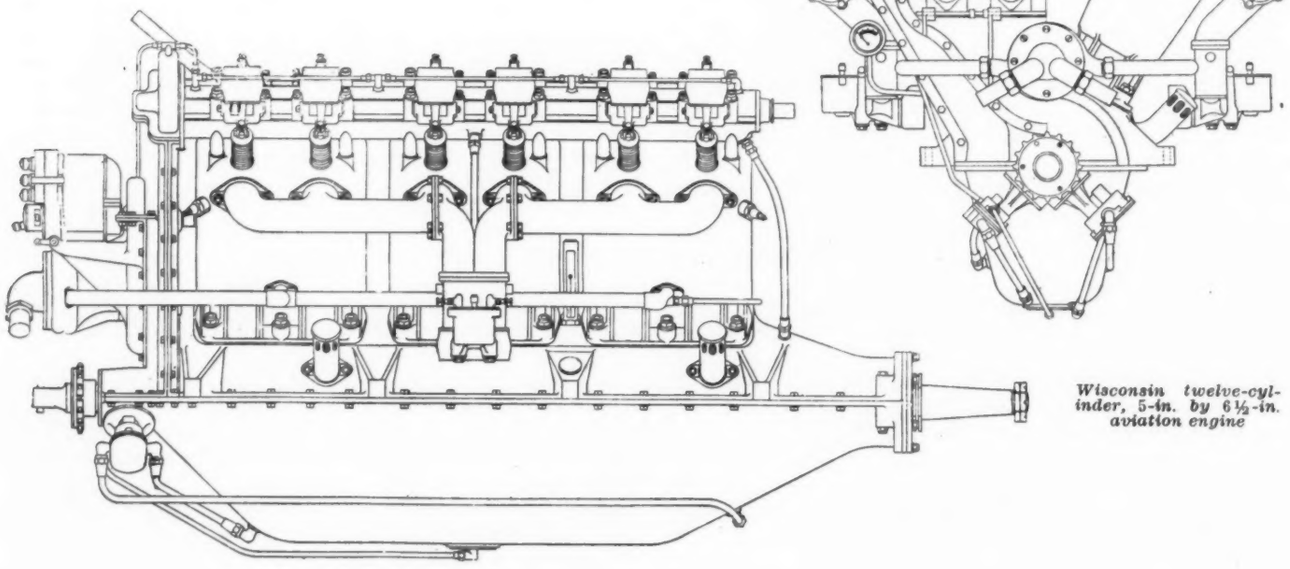
Instead of using cast-iron linings for the cylinders, hardened steel sleeves are employed, the pistons being made of the same grade of aluminum alloy as the cylinders. These pistons are typical examples of the aluminum type having substantial supporting ribs beneath the head. There is no wristpin bushing, the pin being fixed in the upper end of the connecting-rod, operating directly in the piston, as the particular alloy employed is found to be a satisfactory bearing metal.

Plain Crank Bearings

A point of difference from the racing car engine is seen in the crankshaft bearing layout as ball races are not employed at this point. Instead, there are three main bearings of bronze with babbitt facing, these being fed with oil under pressure which is thence transferred to the lower connecting-rod bearings, via the crankshaft. There are no less than three oil pumps, these being arranged on the system origi-



Pistons and connecting rods of twelve-cylinder Wisconsin aviation engine. In the cross section of the pin securing the small connecting rod it can be seen that a recessed plug is used to carry oil from the crankpin to the side rod attachment. Notice the oil pipe within the main rod carrying oil to the piston pin



Wisconsin twelve-cylinder, 5-in. by 6½-in. aviation engine

nated by the Wolseley Co. of England, as two of them are used to remove oil from the crankcase, the third only being employed to force it to the bearings. Both the scavenging pumps, as they are termed by the makers of the engine, are larger than the pressure pump since their object is to keep the crankcase entirely free of oil accumulation. The purpose of this is to guard against any part being flooded should the engine be tilted to a sharp angle.

The scavenging pumps are arranged with different points of suction so that while they both exhaust the crankcase when the engine is horizontal, if it is tilted either one or the other of the pumps will still be in operation.

Oil Is Water-Cooled

It will be remembered that the oil pump and some of the pipes on the Wisconsin racing engine were placed well outside the crankcase where they were exposed to a draft of air, the cooling effect undoubtedly assisting to improve the lubrication. This idea has been elaborated in the aviation engine, since the discharge pipe on the pressure pump is taken through the interior of the lower water pipe on its way to the main standpipe from which oil is delivered to the crankshaft bearings and to the camshaft housing.

As in the racing engine, the surplus oil in the camshaft overflows down the vertical passages containing the bevel driveshaft, thus lubricating the camshaft drive gears. In addition there are also a number of oil return tubes running straight to the crankcase.

Complete Double Ignition

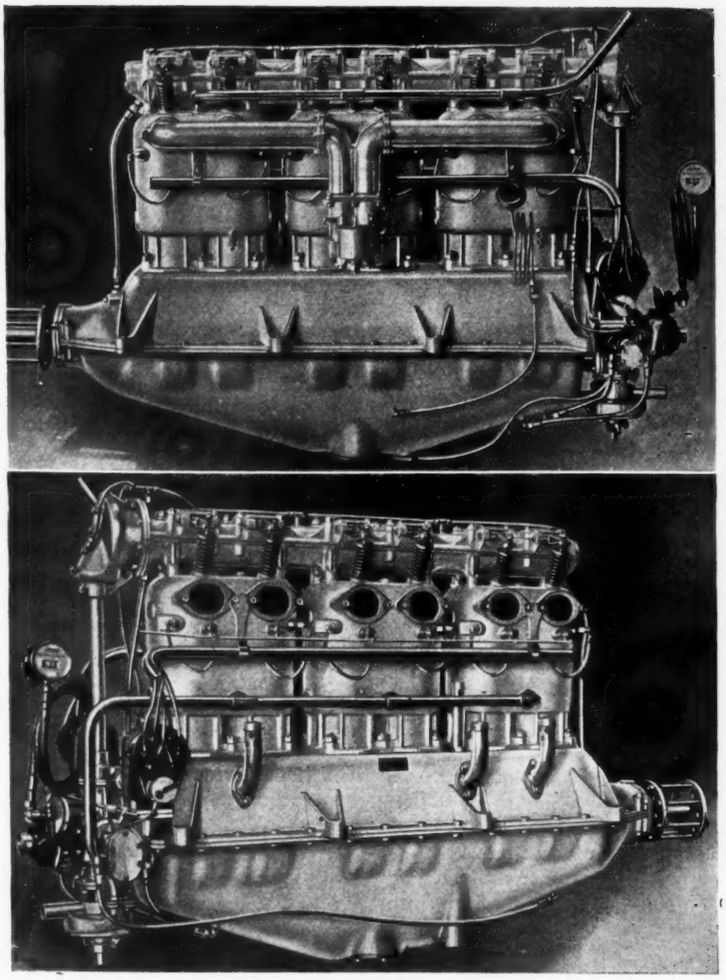
Ignition has been a constant source of trouble in aircraft and, in consequence of this, the Wisconsin engines have complete duplicate magneto systems operating simultaneously. This means that the six-cylinder has two magnetos and the twelve-cylinder four, the spark advance being interconnected. This, of course, means that in each cylinder there are normally two sparks and the Wisconsin company states that the failure of one of these sparks results in slight loss of power. There is very little difference between the six and the twelve-cylinder models, both being of the same bore and stroke and both having 3-in. valves.

In passing, it may be remarked that there are only two valves per cylinder, as against four in the racing engine, this being explained by the fact that the single large valve will operate perfectly at moderate speeds and neither of these engines is intended for very high crankshaft revolutions. One difference between the six and twelve is that the former has an I-beam connecting-rod while a tubular type is used for the twelve.

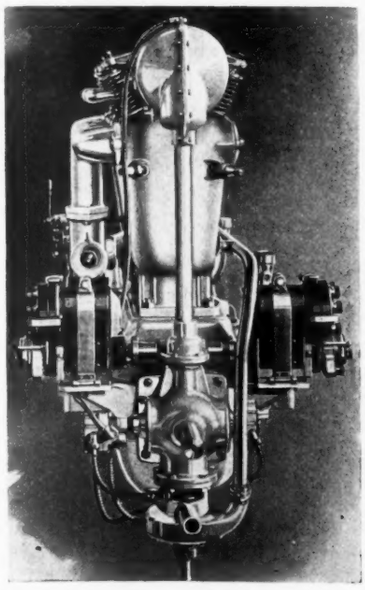
As shown in the cut, the Wisconsin company have adopted the least used type of connecting-rod for the twelve in that it is neither of the forked nor side-by-side pattern, but has a secondary rod linked to the main rod via a lug on the side of the latter.

An outstanding feature of both engines is the extremely fine workmanship employed and the use of the strongest possible kind of steel. The makers state that the six-cylinder engine weighs 600 lb. with carbureter and magnetos and develops 138 hp. at 1200 r.p.m., rising to 145 hp. at 1400 r.p.m. The fuel consumption is 0.6 pint per b.hp. hour. The twelve-cylinder is said to develop 250 hp. at 1200 r.p.m. and 280 hp. at 1400 r.p.m., while the weight of the twelve is listed at 1000 lb. with magnetos and carbureters.

These two engines, while of entirely original design, contain nothing that is abnormal. Like the other automobile engineers who have turned to the problems of flying machine power plants, the Wisconsin company has preferred to make the utmost use of its own wide experience, rather than to adopt some completely new construction. That this has been the American method is a good thing for American flying, because if there is ever a sudden demand for many engines it will not be necessary to find the weak spots in freak constructions as was the case in France in the first months of the war. American firms are tackling the job just as the European automobile manufacturers have tackled it, but America has escaped a very wasteful stage through which the European nations passed.



These views of the six-cylinder Wisconsin show the layout of all the accessories



End view of Wisconsin aviation twelve, showing the location of the two scavenging oil pumps. The layout of the two magnetos is also shown and the drive for the overhead camshaft. This illustration shows well how narrow the engine is, this being a distinct advantage for aeroplane work

Refinements in Truck Design

Abstract of a Paper Read Before the Society of Automobile Engineers at the Summer Meeting on the SS. Noronic

By H. D. Church

Chief Engineer, Truck Division, Packard Motor Car Co.

IN developing the present line of Packard worm-driven trucks, nine different experimental trucks were built and tested. The tests were run over a route in Detroit which was selected to obtain about 75 per cent of the distance over very rough, broken down block pavements. The trucks tested were overloaded continuously, were overspeeded during a portion of their testing, and were, as far as possible, kept in motion 22 hr. a day, 7 days a week.

Under these severe conditions, any faults in design were rapidly brought to light, and this paper will deal briefly with some results obtained from such test service, and also with conclusions drawn from the service result standpoint of 8 years of truck manufacture.

Front Axles

In our worm drive development work we started the use of a front axle design of I-beam section, using the inverted yoke type of steering knuckle, and it is interesting to note that the weight of the 3-ton axle of I-beam design, proved to be 17 per cent less than that of the rectangular Elliot knuckle type of axle formerly used, the stresses remaining the same in both cases. This decrease in weight was obtained in spite of the fact that the I-beam axle was of wider gage than the old type.

In the earlier experimental front axles the steering-knuckle pins were straight where they passed through the axle stock proper, and we experienced a lot of trouble due to the straight pins "belling" out the ends of the hole in the axle. This wear was, of course, in the more expensive piece of the two, and could not be corrected after it took place without re-machining the axle and putting in bushings, which in turn would do the same thing that the straight pin did.

This difficulty was entirely overcome by fitting the steering knuckle pin into the axle end on a long taper, holding it tightly in place with a nut and sleeve at the lower end, as shown in Fig. 1. This practice, in service, proved so satisfactory that it was used for the torque-arm rear end pin, where it passes through a heavy lug on the rear axle cast-steel center housing, a point where wear, due to the "belling" out of the hole, would eventually involve an expensive replacement charge.

On a heavy truck it is difficult to make a substantial connection between the steering knuckle and the steering arm, for the steering gear connecting-rod, this being the arm which carries the entire steering effort. We tried pressed hexagon fits, brazed hexagon fits, and pressed cylindrical fits, with four-key dowels, but all these constructions gave more or less trouble, and we finally forged this one lever integral with the steering knuckle, making the lever a heavy oval section.

Prior to our experimental work on worm driven trucks, we had experienced some trouble with our steering connection joints, which were of the clevis type. As originally designed, the pins were prevented from turning in the clevises by the engagement of a flatted side of the pin head with a machined lug on the steering rod clevis, and the lever eyes were bushed with bronze. The bronze bushings pounded out; so hardened steel bushings were substituted. Then we found the pins pounding out and over-sizing their holes in the clevises, and that the weight of the cross tube and connecting-rod pounded and wore the faces of the eyes and clevisee. We than commenced using hardened steel collar or "plug hat" bushings in the steering lever eyes, and in both sides of each clevis. These bushings were so arranged that the weight was carried on large diameter hardened surfaces, as shown in Fig. 2. This construction was only fairly satisfactory, as the continual pounding from solid tires, coupled with inability to retain lubricant, was the cause of too rapid wear.

We felt that we had exhausted all the possibilities of the pin and clevis type of joint, and turned to the ball-and-socket joint construction, using hardened and buffed balls and sockets, no springs being employed behind any of the sockets. This construction was an improvement over the final bushed eye and clevis design, as shown in Fig. 2, but still wore and rattled. The wear was obviously due to the slight clearance between the bearing surfaces, through which the vibration resolved itself in a succession of light hammer blows, the intensity of which increased with wear.

We next tried placing a spring behind one of the ball sockets in each joint, in order always to retain all three parts in close contact. Some experimenting was necessary to determine on a spring pressure heavy enough to allow only a slight deflection under steering effort and road shocks, in conjunction with balls of a size such that the unit pressures could be kept low enough not to cause hard steering. This construction is shown in Fig. 3.

Excellent results were finally obtained on a 3-ton truck with ball of 1⅝ in. diameter, in conjunction with a spring compressed to 300 lb. The balls and sockets are made of steel and hardened. The writer has measured balls after 30,000 miles of service, which showed less than 0.003 in. wear on the diameter, clearly indicating how the construction stands up.

Rear Axles

In 1911, when we started experimental work on worm-drive rear axles, very little information on worm gearing for truck rear axle work was available in this country, and our decision to develop an axle of this type was based largely on foreign practice. We investigated carefully the construction and service results of internal gear and worm drive axles in Europe, and were deeply impressed by the wonderful results obtained with worm gearing on the chassis of the Dennis and the London General Omnibus companies.

At that time the Hotchkiss drive looked promising, and that construction was embodied in our first worm-driven vehicle. After many months of spring breakage trouble we arrived at a design of spring with the driving eye at the rear end, which gave good satisfaction in ordinary service. On a heavy vehicle we found it impossible to make the springs as durable with the Hotchkiss drive construction as with the torque-arm and distance-rod construction, and after exhaustively testing a model with distance-rods and no torque-arm, which

resulted in an objectionable chatter when using the transmission brake, we finally decided upon the conventional type of construction, using both distance-rods and torque-arm.

Right at the start we began to have trouble with the axle driveshafts twisting off at the outer ends. European practice is to use a rigid connection at this point, between the driveshaft and the wheel hub, chiefly in connection with a floating bronze bushing for the rear wheel bearing. With the taper roller bearings, which are largely used in wheel hubs in this country, a slight amount of play is necessary in the bearings, which permits the wheel to rock slightly. This slight rocking of the wheel, in conjunction with a rigid connection between the driving shaft and the wheel hub, subjects the shaft to bending, and we found that these bending loads, in our case, were the cause of shaft failure.

For the rigid connection between the shaft and the wheel hub, we substituted a four-lug semi-universal construction, which permits a slight rocking of the rear wheel without placing any bending loads on the shaft, as shown in Fig. 4. The driving plate, which attaches to the hub, is hardened, and the driveshaft, on account of its heat treatment is also hard, so that the driving loads are taken through hardened surfaces. The pressures per square inch on these driving surfaces are as follows:

On low gear.....4230 lb. per sq. in.
On high gear.....1290 lb. per sq. in.

The wear in normal service should not exceed 0.004 in. in 30,000 miles. Since using this construction we have, so far as the writer is aware, never had a failure at the outer end of the shaft, either experimentally or on any of the thousands of trucks in service.

We also had trouble at the inner end of the axle shafts, where they engage the differential gear hubs, these failures occurring on trucks in extremely heavy service, which were fitted with high reduction worm gears. The shafts twisted off where the six splines on the inner end run out into the round of the shaft, and practically at the end of the differential gear hub. These axle shafts were made of a nickel-chromium steel, heat treated to the following physical properties:

Tensile strength.....155,000 lb. per sq. in.
Elastic limit.....120,000 lb. per sq. in.
Elongation .....16 per cent

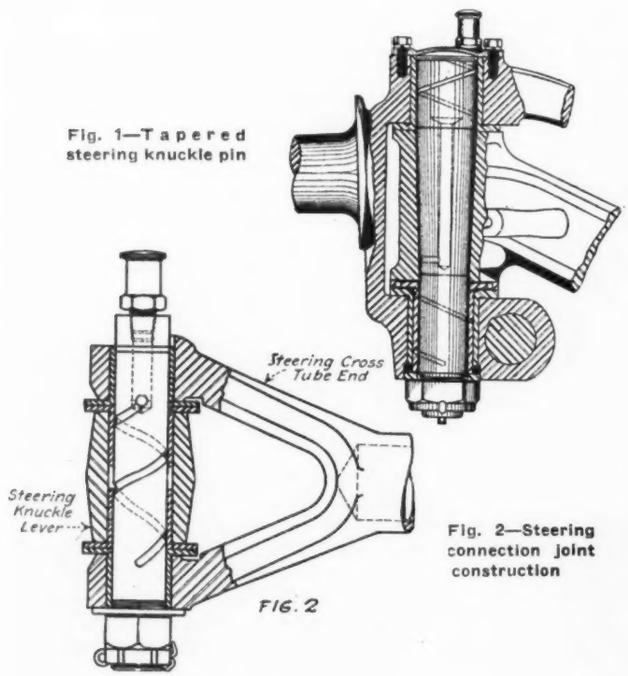
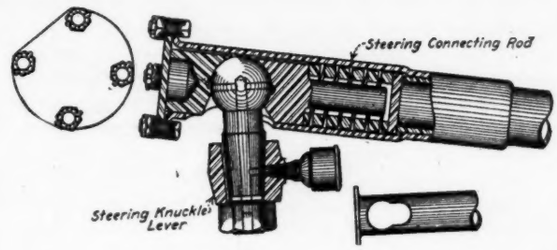
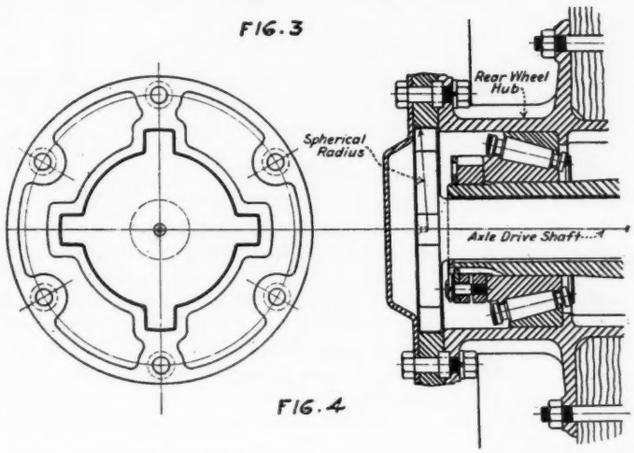


Fig. 1—Tapered steering knuckle pin

Fig. 2—Steering connection joint construction





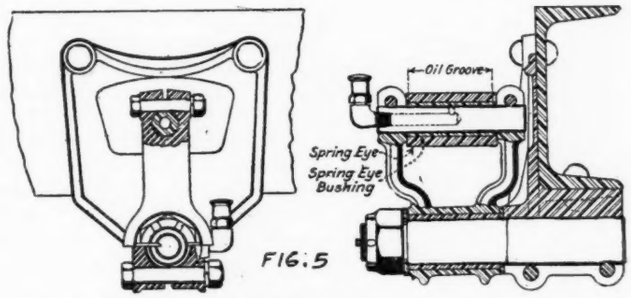


Fig. 3—Rod with ball-and-socket joint. Fig. 4—Connection between driving shaft and wheel hub. Fig. 5—Method of lubricating shackle pin

Reduction of area.....48 per cent
Hardness (Scleroscope).....50 per cent

On the 3-ton truck, with high reduction worm gears, these shafts were stressed as follows:

On low gear.....26,400 lb. per sq. in.
Due to foot brakes*.....63,400 lb. per sq. in.

And it is interesting to note that in every case of failure the shafts were twisted off from the low gear loads and not from the transmission brake loads.

In order to overcome this twisting off of shafts, we made slight changes in the chemical composition of the steel, and changed the heat treatment to obtain the following physical properties:

Tensile strength.....185,000 lb. per sq. in.
Elastic limit.....175,000 lb. per sq. in.
Elongation .....11 per cent
Reduction of area.....50 per cent
Hardness (Scleroscope).....64 per cent

To obtain these properties two heat treatments are required. The only way high stresses in the shafts can be avoided is to increase the shaft diameter materially, and such a proceeding is not desirable, as the weight of the entire axle structure builds up around the driveshaft diameter.

On our experimental worm-drive axles we experienced some trouble with overheating and subsequent failure of the double

*Stresses for foot brake determined by using coefficient of friction of 0.6 between tires and road.

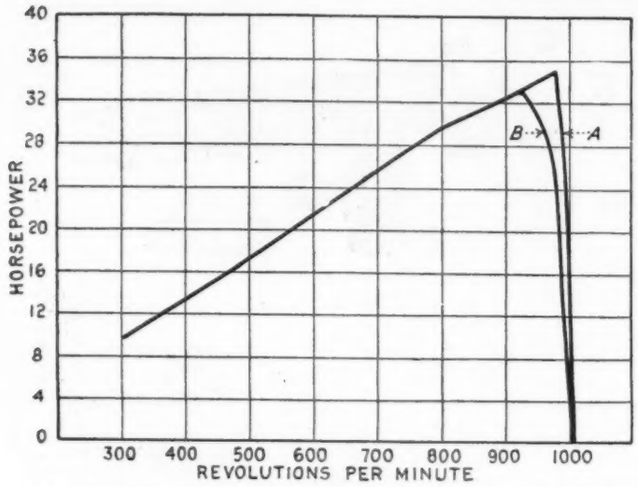


Fig. 6—Effect of governor operating and closing. Curve A, action going up. Curve B, action going down

ball thrust bearing behind the worm. By building up a dummy housing with cutout sections on top, and driving the worm by belt, we found that practically all the surplus oil carried up to the worm by the wheel impinged against the front annular ball bearing on the worm shaft, and that very little of it was forced into the thrust bearing and the annular bearing at the rear.

A cast oil trough inside the housing was provided to catch the oil thrown off the worm, and from the trough the oil was led through a cored passage into the thrust bearing housing, and allowed to find its way back into the axle case through the worm rear annular bearing. This practice provides a gravity circulatory oil feed for both rear bearings, and has been found, in service, to insure adequate lubrication.

There has been some discussion recently concerning the efficiency of worm gearing, as against that of the double side chain or the internal gear final drive. If a side chain or internal gear final drive is new, and properly lubricated, then under conditions of low rotative speed and heavy torque, the worm drive is less efficient. However, neither side chains nor internal gears can be kept lubricated, and are consequently subject to rapid wear and deterioration, while the worm drive, being completely inclosed, and running at all times in a bath of oil, is just as efficient after 30,000 miles or more of service as it is when new.

It has been the writer's experience that the truck owner is very much more interested in obtaining the minimum cost per ton mile, than in any theoretical discussion of efficiency. In considering the various forms of final drive, there are many factors which are of greater importance than the efficiency consideration. Minimum maintenance cost, durability, silence, freedom from the necessity of frequent attention, are all of more importance than efficiency, when the efficiency differences are so slight that they cannot be measured in gasoline or oil consumption.

While the manufacturing cost of a worm drive is greater than that of side chain or internal gear drives, the fundamental reason for its wide-spread use and success lies in the fact that over a given period of time and mileage, its maintenance cost is materially less than that of either of the other two forms.

Spring Shackles and Pins

These parts have been the source of a great deal of trouble in the past, because of improper lubrication and wear. The writer has never seen any grease cup having sufficient power to force grease into the loaded side of the bearing, even with no load on the truck. Grease can be forced in by using a special gun, but such a procedure, while it might be satisfactory for the owner of a fleet of trucks, is hardly feasible for the owner of one or two vehicles. When grease cups are used in conjunction with grease grooves in the pin, these grooves can be filled up with grease, but further screwing in of the grease cup only squeezes the grease out on the non-loaded side of the bearing, or by the grease cup plunger or cap. It has been our experience that grease in such grooves is never properly distributed over the loaded surfaces, as the angular motion between surfaces at this point is too slight.

This lubrication difficulty can be overcome by using oil instead of grease, feeding it into a groove along the top side of the shackle pin, whether it is the loaded side or not. The groove should be shorter than the spring bushing, and the oil-cup so arranged as to give a slight head above the groove, as shown in Fig. 5.

When the oil cup is filled, the truck is stationary and the bushing acts as a seal over the oil groove. In motion, road vibration lifts the bushing slightly away from the pin and permits the oil to flow over both sides of the groove and around the entire pin to the bottom, or in the case of a shackle pin, where the load is normally on the bottom, the oil runs over the sides of the groove and flows down around the entire pin. If desirable, felt can be used in the communicating hole between the oil cup and the oil groove, in order to cause a gradual flow of oil. This system has proved very satisfactory in service, one filling of the oil cups in the morning providing sufficient lubrication for a day's run of the truck.

The writer's experience has been that even if the shackle pin is a good fit in the shackle, and is held either by a key or a flatted lug against any rotative motion in the shackle, it cannot be prevented from wearing the holes in the shackles out of round. In time this condition also partially cuts the pin in two, and after much of this kind of wear has taken place, replacement of both the shackle and the pin is necessary; and removal of the pin for replacement is very difficult. Working on the assumption that the wear is caused by countless little hammer blows, due to inability to make the pin initially a tight enough drive fit in the shackle, the construction was changed to clamp each end of the pin in the shackle, the clamp bolt being notched into the pin and so arranged as to hold the two surfaces tightly in contact. This construction, shown in Fig. 4, has been the means of obviating entirely any trouble due to wear of the shackle or the shackle pin where they come in contact.

Radiator and Hood Mounting

The writer has experimented with several different radiator mountings, rubber cushions, coil springs, and C-shaped flat springs. The results of these experiments showed a rigid mounting to be impracticable, and that flexibility in mounting is more essential than extreme cushioning. Truck radiators are more frequently injured by the strains put upon them from chassis frame distortion than from vibration, and the most desirable mounting is one which permits frame distortion without straining the radiator assembly and which, while giving a certain amount of cushion effect, is still rigid enough to prevent excessive vibration of the entire radiator on its mounting.

It has been the writer's experience that it is impracticable to carry the front end of the hood on a ledge which is integral with the radiator casing, as if the radiator is carried on a semi-flexible mounting, it has a slight vibratory motion, relative to the chassis, which results in destroying the hood hinges and tearing out the rivets at the front end.

We are now carrying the front end of the hood on an angle-iron frame which is bolted to the chassis frame, just back of the radiator. This frame is entirely independent of the radiator and carries a water drip molding to prevent the entrance of water between it and the radiator. The construction is simple and cheap, and has quite overcome the trouble we have experienced in the past, due to the hood rubbing and

chafing its supporting ledge entirely off the radiator casing, and destroying itself and its hinges in the process.

The subject of radiators naturally brings up the fan-belt question. A fan-belt is one of the most troublesome little things with which a truck designer has to contend. Of course, in truck practice, the conditions under which the fan-belt must operate are unusually severe, as the fan speed is fairly high and the pulley center distance is short. We run our fan at approximately 1400 to 1000 r.p.m. of the engine, and have never yet found a belt which, running on 14-in. centers, has what we consider sufficient life. We have tested many different kinds of belts, both flat and V-section, but have found nothing better than the riveted segmental V-belt, and that is not entirely satisfactory. It is to be hoped that some of the belt manufacturers will develop in the near future a fan-belt which will give at least 100 per cent more life than the types at present available.

Governors

All our experimental and regular service data point to the advisability of using a governor to limit the maximum engine and truck speed. It is the writer's opinion that chassis depreciation increases almost directly as the square of the road speed, but it is manifestly illogical to try to govern all trucks of the same capacity to run at the same maximum speed, irrespective of operating conditions. For instance, a truck which is governed to the best speed for proper life and maintenance costs for operation over the rough streets of Pittsburgh, ought to be capable of running faster with no greater depreciation over level asphalt streets in Detroit.

Higher Speeds Expected

As truck engine and chassis design improves, higher engine and road speeds are going to be permissible, and the increase will probably be obtained by speeding up the engine and possibly making it smaller, using somewhat higher gear ratios in order to obtain the present activity factors on direct drive. Betterment of city road conditions will also help to make higher road speeds allowable. The writer has carried on a great deal of experimental work on centrifugal governors in order to obtain the minimum speed range for governor action without "surging" or "hunting." Assuming maximum engine governed speed is 1000 r.p.m., the governor should not cut into the horsepower curve any earlier than necessary. Our earlier governors used to start acting at 925 r.p.m., closing the throttle tight at 1000 r.p.m. After a great deal of experimental work, we have developed a governor which starts to close the throttle at 950 to 975 r.p.m., and completely closes it at 1010 r.p.m., giving a range of 6.4 to 3.4 per cent. With the engine running at 1000 r.p.m. under light loads the governor should open the throttle as quickly as possible, when the engine speed decreases from an increase in the load, but owing to the friction to be overcome in starting governor action, the governor will not open within as close a range as it closes the throttle. This difference in opening and closing action is shown on the curve in Fig. 6. The curve was made from a 4½ by 5½ in. engine, the loads being checked in speed increments of 25 r.p.m. at all speeds above 900 r.p.m. The governor, with the characteristics shown, does not hunt or surge on the road, and has a very "snappy" action, opening or closing very quickly, according to variations in the road resistance offered to the progress of the vehicle.

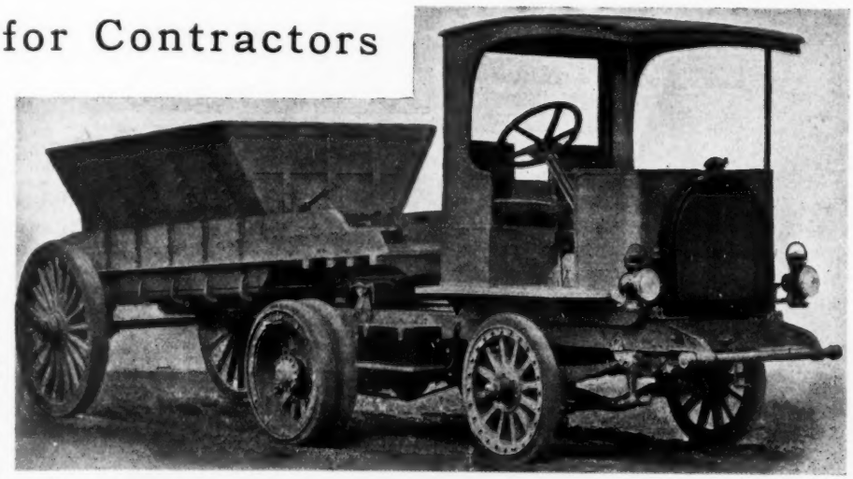
Unsprung Weight

There has been considerable discussion recently concerning sprung versus unsprung weights on trucks, with particular reference, of course, to the rear axle construction. While the writer has as yet no conclusive data on the subject, it is his opinion that within reasonable limits, unsprung weight on a truck is not a disadvantage. Unsprung weight on solid tires, at comparatively slow speeds, is not analogous to unsprung weight on pneumatic tires at high speeds. We once made a visual check on contact between the tires and the road, by running a worm driven and a chain driven truck at the same speed over a stretch of rough pavement, making the test with the trucks both loaded and unloaded. When loaded, both trucks carried the same weight on the rear tires, but when unloaded, the worm driven truck was slightly heavier in the rear. So far as could be judged by careful observation, the tires of the worm driven truck left the road fewer times than those of the chain driven truck, either when carrying a load or running light. This condition could indicate greater tire mileage for the worm driven vehicle, as it is obvious that when the engine is pulling, tire wear must be increased when a tire leaves the road and accelerates somewhat while in the air, due to the differential, and is suddenly brought back to its original speed by slippage against the road surface upon its return to contact.

The rear axle unsprung weights of the two vehicles tested were 2162 lb. for the worm driven, and 1612 lb. for the chain driven, both trucks being of 3-ton capacity. The side chain driven truck admittedly results in the lightest unsprung weight construction. It is interesting to note that the increase in unsprung weight of the worm drive axle over the chain drive axle is only 550 lb. or 275 lb. per wheel.

Watson Tractor for Contractors

IN designing the Watson tractor the Watson Wagon Co., Canastota, N. Y., aimed especially to meet the requirements of the contractor. The 5-ton tractor is illustrated herewith attached to the Watson 120 cu. ft. semi-trailer. This outfit can turn without backing in a 31-ft. circle. The tractor's wheelbase is 80 in. and that of the semi-trailer, 11 ft., 3½ in. The tractor uses a four-cylinder Continental motor with 4½ by 5½-in. cylinders cast in pairs, the power plant, radiator seats and steering gear being carried on a subframe to eliminate jar. Other features are: Timken worm gear rear axle; Bosch DU4 high-tension magneto with Duplex coil for starting; Pierce governor; Brown-Lipe four-speed selective gearbox; Gemmer steering and Sheldon springs.



Watson 5-ton tractor and 120 cu. ft. semi-trailer

The Search for the Army Truck Wheel

The Composite Wheel (1) as Front and Trailer Wheel (2) as Driving Wheel—An Examination of Its Possibilities

(Continued from June 22, pages 1122-1124)

By Marius C. Krarup

AFTER dealing in the first part of this article with the characteristics in the operation of composite wheels—of the type diagrammatically shown in Figs. 1 and 2, which are repeated herewith—for use as front wheels or trailer wheels (that is, as wheels that are pushed or pulled from the axle), the more doubtful use of the type for driving wheels now comes up for consideration, and this must be less general and more searching with regard to all quantitative factors, since this type of wheel has been tried, though only in primitive forms and under primitive conditions of service, more than once in the past and yet has failed to make its way into general automobile practice or even into the heavy transportation work for which it is probably best adapted.

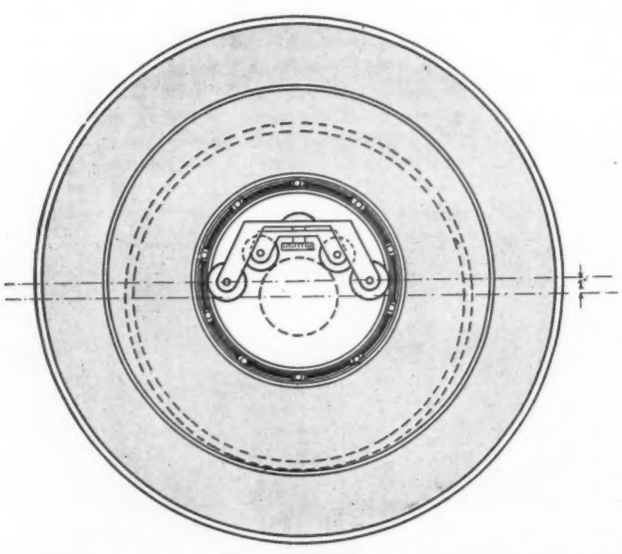
An inaccuracy in the first installment may be corrected first. Lines 16 to 11 from the bottom on page 1123 should read: The change in the location of the load pressure *in conjunction with the direct pull which may be received from the tractor additionally* must be sufficient to turn the road wheel over before the point of slippage is reached—the words here printed in italics having been omitted.

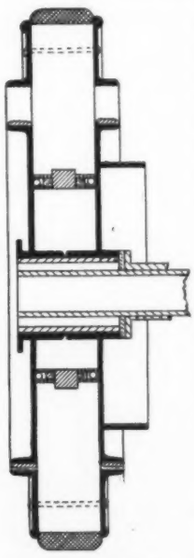
Fig. 3 illustrates diagramatically the factors and considerations which enter most prominently in the operation of the type as a driving wheel. The eccentricity of the driving wheel component in relation to the road wheel component is shown somewhat greater than in Figs. 1 and 2, partly to make the drawing plainer and partly as an indication that for heavy traction the more marked eccentricity figures out more favorably, while less desirable in the matter of making the wheel compact and attractive in appearance. The test equation presented in the following supplies a ready means for deciding the degree of eccentricity which it may be necessary to incorporate in a driving wheel of this type for any given set of service conditions, l and R being the factors affected which may be tried in the equation with different values or isolated and worked into separate formulas.

The first thing to be shown is the (1) general capacity for operating, and for this purpose the condition of a level but very heavy road is chosen. It is assumed that the friction between the driving wheel component and its track upon the road wheel component is secured by the choice of suitable materials, so that the contact point between them can rise to an angle of at least 60 degrees without chance of slippage occurring. While no greater angle than 45 degrees is employed in the example relating to steady running against heavy traction resistance, the larger angle may be desirable for starting or emergencies.

The Doubtful Points

Other conditions to be considered separately, but to which the test equation furnishes the principal clue, relate to (2) maximum speed, to (3) driving on rough roads, to (4) uphill work, to (5) downhill work and (6) braking, to (7) slippery roads and to (8) the possibility of designing this type of wheel in such proportions that the total gear ratio of a vehicle remains unchanged if the composite type is substituted for the ordinary type. Similarly the question of arranging the composite type in such manner that it may be transformed by simple adjustment into a wheel with ordinary wheel action comes up for consideration, provided it is made clear or probable that the type can be used advantageously for certain sets of conditions but not so well for other conditions which also may be encountered in the same service.





Figs. 1 and 2—Diagrams showing principal features in wheels of composite type

Fig. 1—Side view of the middle or road wheel component with tracks and thrust bearings. Device for maintaining contact of wheel sheaves with the tracks is shown in the central circular opening. Relations to axle and hub carrying the wheel sheaves are indicated in dotted lines

Fig. 2—Vertical section of assembled wheel, with omission of hub details and the central device. Brake drum is shown as integral part of the driving wheel sheave on the side of the wheel nearest the vehicle

The general capacity for operating is now to be looked into.

When power is applied and driving wheel Q is rotated forward from contact point a, there comes a moment, as when contact point b has been reached and the load L is held by the motive power at angle α, when the pressure of the load is balanced by the traction resistance. The road wheel Y still does not move, or its movement can be considered as infinitely slow. But any more advanced position of the driving wheel, such as with contact at c, causes the road wheel to turn and the vehicle to advance and to acquire momentum, the speed being determined by the angle β and a number of other factors subsequently referred to.

There is first to be determined whether the angle α is likely to be small enough to agree with practical requirements in the

starting of a vehicle, since it represents the minimum advance of Q necessary for producing vehicle movement. One has the equation

$$L \times \frac{R \sin a}{p} = L f + W f \text{ or } \frac{R \sin a}{p} = f\left(1 + \frac{W}{L}\right)$$

Where f is the coefficient of resistance to traction, L the load on the wheel at b, W the weight of the road wheel Y and p the distance in front of A at which traction resistance may be considered as concentrated, as depending on the hardness of the road (for given values of L and W and the wheel dimensions). $\frac{R \sin a}{p}$ is then the leverage with which L is to overcome the traction resistance $f(L + W)$.

The equation, since it represents equilibrium, determines the maximum value for f.

$$f \text{ (maximum)} = \frac{R \sin a}{p\left(1 + \frac{W}{L}\right)}$$

As W should be relatively small, one has approximately $R \sin a = pf$ or, more accurately, $R \sin a = pf\left(1 + \frac{W}{L}\right)$.

As f does not exceed 20 per cent in deep sand and p under this condition reaches perhaps a maximum of 6 inches, the system can begin to start a vehicle under these very unfavorable circumstances when $R \sin a = 6'' \times 0.20$ (approximately) $= 1.20''$; and this makes a quite a small angle if the value for R—the radius of the driving-wheel track—is in the neighborhood of 15 in.

In the case of a steam vehicle or a gasoline motor truck with hydraulic transmission, these relations should be decisive to show that the composite driving wheel system will permit starting and operation at one speed or another. But for ordinary gasoline motor trucks the practical question relates to starting and running at the speed giving maximum torque for driving wheel Q, and this is the speed obtained on low gear with the motor running at normal speed. It may be 3 or 4 m.p.h. Let it be given as m m.p.h. vehicle speed. The question is then: At m m.p.h. what are the limit values for β, f and p, β being the angle, larger than a, at which a desired vehicle speed is produced)?

To avoid considering the initial acceleration of the vehicle at the start and the storing of kinetic energy, which is kept constant during running at uniform speed, the running conditions only are considered. This should be permissible, since it has been shown that a start at one speed or another is effected as soon as load L is rolled forward to contact b, even if f and p are very high.

The question of being able to apply the driving power to advantage now becomes that of deciding if the traction resistance encountered in moving the vehicle at m m.p.h. can be overcome for a given distance by the wheel action in the same length of time that the vehicle speed places at disposal. While vehicle advances the length of the arc ac at m m.p.h., can L fall the distance l which it must fall by reason of this vehicle movement and at the same time overcome the resistance to traction?

It is noted that while the power is continually keeping Y in contact with Q at c and keeping β constant (under the supposition of uniform vehicle speed here contemplated), the gravitation of L takes place independently. The rotation of Q nullifies the fall of L by exactly offsetting it, but when Q rotates as far as from a to c it offsets just the opposite movement of Q which would take place if no power were applied. The power thus raises L the height l, and the power thereby stored is the power available for overcoming the traction resistance. If this power is superior to the traction resistance, acceleration takes place, but it is here the question of examining the conditions for uniform speed. Hence we use an equation expressing the driving action taking place in the same length of time as required for the corresponding

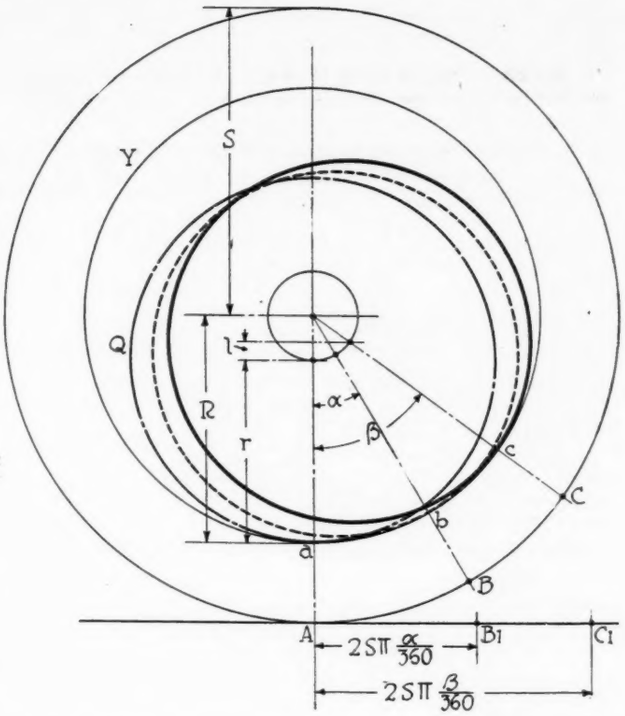


Fig. 3—Diagram illustrating factors which enter quantitatively in the operation of composite wheel type as traction wheel

vehicle movement (to make low gear torque of gasoline motor vehicle fully applicable):

L unrestricted would fall through height l in the time in seconds, $\frac{1}{4}\sqrt{l}$, (taking acceleration g as 32 ft. per second), but with resistance to overcome which equals $fp\frac{L+W}{R \sin \beta}$ if the fall of L shall be made uniform in velocity (in accordance with the foregoing), the time t for the fall is increased in the proportion which the resistance holds to L. One has therefore

$$t = \tfrac{1}{4}\sqrt{l} + \tfrac{1}{4}\sqrt{l} \times \frac{fp\frac{L+W}{R \sin \beta}}{L} = \tfrac{1}{4}\sqrt{l}\left(1 + \frac{fp}{L} \cdot \frac{L+W}{R \sin \beta}\right)$$

And as this time must equal (not exceed) the time in which vehicle advances $\frac{2S\pi\beta}{360}$ at m m.p.h., which is equivalent to $m \times 17.6''$ per second, the test equation becomes

$$\tfrac{1}{4}\sqrt{l}\left(1 + \frac{fp}{L} \cdot \frac{L+W}{R \sin \beta}\right) = \frac{2S\pi\beta}{360} \cdot \frac{1}{m \times 17.6} \text{ second}$$

in which all the linear measurements are inches and S the radius of the road wheel Y.

Example in Figures

If this equation gives a value for m (which stands for number of miles per hour) that agrees with practical values for l, f, p and β and with the vehicle speed at which a gasoline motor vehicle is best able to handle a heavy load on difficult roads, then a presumption seems to be established to the effect that the composite wheel system can be used, but it must be shown thereafter that it has special advantages and can be used on hills.

The values to be inserted in the equation may be as follows, making f and p represent high traction resistance, as in sand:

$S = 20'' =$ Road wheel radius
$R = 15'' =$ Radius of driving wheel track
$r = 12'' =$ Radius of driving wheel
$\beta = 45° =$ Angle maintained for high resistances to traction

$$l = R - r\,(1 - \cos\beta) = 3 - \frac{3}{\sqrt{2}} = 3 - 2.127 = 0.873$$

L is not important, since it is divided by itself in the equation, but its value may be taken at 1000 lb. with the value for W, the weight of Y, at 50 lb.

$f = .20$ = Coefficient of traction resistance in sand

$p = 6''$ = Distance in advance of A where f operates

These figures make the equation:

$$\tfrac{1}{4}\sqrt{0.873}\left(1 + \frac{0.20 \times 6}{1000} \times \frac{1050}{15 \sin 45}\right) = \frac{20\pi \times 45}{180} \cdot \frac{1 \text{ second}}{m \times 17.6}$$

$$0.2335\left(1 + \frac{1260}{10640}\right) = 0.2612 = \frac{15.7295}{m \times 17.6}$$

Here the left side of the equation shows that the wheel action involved, including the overcoming of the traction resistance, occupies 0.2612 sec. or about ¼ sec. Proceeding to get a value for m, one has

$$m \times 17.6 \times 0.2612 = 15.7295$$

$$m = \frac{15.7295}{4.59712} = 3.41 \text{ m.p.h.}$$

Even under the difficult traction conditions assumed vehicle can thus be operated with full benefit of the best torque and power, if the motor and gear reduction are such as to provide for normal motor speed when low gear produces a vehicle speed of 3.41 m.p.h. and the load on front wheels is not excessive. The load on the front wheels is here supposed to be taken care of in the large allowance for traction coefficient and p, in the margin left for increasing β, if necessary, up to the point where slip is likely to occur, and in the presumption of having front wheels of the same system as the traction wheels and thereby avoiding excessive resistances. But it is, of course, possible to modify the equation so as to make it include the front wheel resistances directly. The equation can, of course, be tested for high vehicle speed and smaller traction coefficients, as well as for different values of the dimensions.

[It may be doubtful, it occurs to the writer in revising these pages, if the leverage with which load L overcomes traction resistance should not be accepted as $R \sin \alpha - p$ instead of $R \sin \alpha$ divided by p. If this view is taken, however, the driving ability of the system is shown more favorably.]

(*To be continued*)

Paragraphs on Current Topics

By Marius C. Krarup

Motto: Radical Thought, Conservative Action

The real subject of this week is: Dusty or Dustless America—Which Shall it Be? For the roads make the only clouds that obscure the brightness of the belated summer. But the haunting vision of Dustless America calls for the building of one million miles of dustless roads—which would only be a road around every township six miles square, or at that rate. The cost would be that of a war, a pretty big war, but having the prosaic fault of being likely to come back with interest on the investment it seems excessive to the taxpayer who first of all wants dramatic interest. No, no more; a ten line paragraph would burst with insufficiency for holding this subject down. Dust, Roads and War, mentioning them in their order of importance, are combinedly more than a mouthful.

The Boundless Gangster Philosophy

Fewer persons know all the facts worth knowing in the management of any big thing to-day than ever before in history; mainly because there are more facts to be known. The complication of the world machinery becomes the ignorance of the individual. He is more liable to be fooled. The art of co-operation among specialists must be the cure for the resulting biological incompetence, extending alike to the leaders and the led, as in Europe's war. And here, in the art of co-operation, business men and engineers can give pointers to statesmen.

On this profound basis we begin to realize that the S. A. E., having now started on a policy of expansion of its activities and scope, should deliberately embrace statesmanship. The Automobile Club de France did so long ago. Industrial Preparedness furnishes the entering wedge. One S. A. E. foot is firmly jammed in the doorway and can hold it open for a spell, while plain members are warming up to their opportunities. Then there is the presidential campaign offering a chance for any S. A. E. orator who can learn not only to drop his pies and exes—that is easy for most of us—but also to shout fallacious platitudes with real fervor and to abandon completely that fine reserve by which engineers who respect the rules of the guild manage to convey that they would have a world of more interesting things to say if they were not restrained by grave professional considerations and responsibilities—but which is lost ignominiously on an untutored populace.

Perhaps there is not really any good reason why the S. A. E., or any other society which has gained a foothold, should not aspire to rule the world. Any society can stick to its last, like a shoemaker. Saint Simon, Auguste Comte and Nietzsche might all be quoted for expanding the activities of a bunch of men as far as they will stretch. How may the world otherwise find out who is fit to rule it?

On Advertising and Culture

As noticed last week, fastidious literary persons are finding fault with automobile advertisements. This is serious. Literature has had ample time to get used to the automobile way of doing things. Yet it does not always fall in line in the right spirit. It cajoles one minute and jeers furtively the next. Automobiles and Culture are not referred to in one breath, in the public prints affecting literary selectness, as often and spontaneously as needed for inculcating a proper and instinctive perception of their intimate association in the social structure. Being practical persons and determined to remedy this situation, we issue the following:

NOTICE.—Every now and then ex-President E. of Harvard receives press notices from other sources. No doubt, they are paid for. If he will shorten up that 5-foot shelf of books which he recommends as sure to produce a high grade of culture (if read), making it about 9 inches, and will include two or three substantial works on motors and automobile construction, we will let him have some free and high-class advertising. Until then, nothing doing.

We want a 40-hp. culture, if you please; one with a honk that scats the crowd.

Mechanical Inklings

A few months ago the number of cylinders was eagerly discussed. To-day it has been tacitly resolved that this subject is a good one to turn over to public opinion without comment. But now the slap of the piston has caught the ear of the wakeful. And what is the slap? Something like the Emperor's New Clothes in Anderson's tales, which could not be seen by anybody who was not fit for his job. It takes

special ability to hear the slap. Yet there is a murmuring about crossheads, with all they imply, to be sure of getting away from the faint sound. The exaggeration must wear itself out, but the refinement of suppressing the slap will surely be effected, wherever it may be needed, by some simple means quietly devised—perhaps only a change in dimensions of rings and grooves for aluminum pistons; perhaps a new little find in the design of steel pistons of the divided type with lengthened trunk and reduced weight.

The most dissenting opinions may be heard as to what the final type of heavy business truck will be. One of them, we venture to say, though with fear of contradiction, will have front driving with fifth wheel steering, a short wheelbase and an auxiliary small motor to drive the rear axle when needed. There will be no mechanical connection between the motors, but one will time the other through the resistance to propulsion. The rear one will have a single radical reduction gear, giving 4 m.p.h. at 800 r.p.m., with twice this speed possible and the fuel charge and composition under positive control at any speed. It will be air-cooled and easily dismountable. It will be started and stopped by clutching and unclutching it by action from the driver's seat. The fuel will not be fed through a carbureter.

If every city had X/a square miles of central area within which 4 m.p.h. was maximum vehicle speed, excepting bicycles only, a development of low-gear mechanism or low power application would follow whose effects would be incalculable. For eventually people must learn that they are not really very often in such a hurry as they now assume they always are. At the same time, belt line automobile streets would come into existence and soon would become modern Pradas, centers for light, leisurely and elegant activities along the sides and bustling with rapid vehicle traffic between the curbstones. Whether desirable or not, such an evolution comes logically hard upon the heels of the exploded contention that speed relieves congestion, which is mathematically correct but humanly impossible where little Fluffy with the saucy eyes, deep in the cushioned corner of the limousine, would rather occupy 100 sq. ft. in the street than 2 sq. ft. on the sidewalk, and insists on it.

□□□□

"Again a man having much to live with, if not for, died from skidding," is the brief obituary noticed in *Index of Contemporary Thought*—a journal often found in taxicabs and streetcar seats. But is this a mechanical, a psychological or a sociological item?

Aeroplanes for Sport and Utility

By Marius C. Krarup

WHETHER aeroplane construction is or is not to be taken up by a goodly number of automobile manufacturers, several are contemplating the possibility. Two years of hammering reports on the aeroplane feats of the war have made the expectation of a public demand for aircraft more plausible than it was previously. The impression created is one of enormous strides of progress in their construction and of huge profits in supplying the machines. In reality, though the metallic construction details are better and more easily obtained than they were, the general design shows so far no radical progress. The equipment with gyroscopic safety devices represents the most important improvement. The rest is greater size, more powerful motors; hence more speed or more carrying capacity, one or the other or a little more of both. Increased speed capacity means a quicker and therefore a safer start, but on the other hand a greater demand for skill in both starting and landing. In the air it means additional safety in some degree, but mostly when held in reserve for instantaneous application in the atmospheric emergencies known as holes or rivers in the air, which can render the steering gear and even the gyroscope ineffective for a moment that becomes fatal to the less skillful and, if the machine is near the ground, to any operator. The earth remains attractive and hard to dodge. The greater number of skillful operators and the much wider diffusion of knowledge useful for deciding on the type of aeroplane that is best for a given purpose seem to constitute the most promising factors, in addition to the gyroscope accessory, which make the situation different from what it was two years ago—so far as aeroplanes for pacific purposes are concerned.

No reports on the gyroscope are so explicit as to make it safe to infer that this balancing device is worth more in peace than in war, where it does not seem to be used extensively, interfering perhaps with the daring swoops and rapid maneuvering demanded for military efficiency. The hydro-aeroplane type is still at the mercy of rough waves and weather when it lights on the water. No small-power hydro-aeroplane has been evolved.

The automobile manufacturer in looking into the situation takes note of these things of course. Either he contemplates to manufacture for military purposes alone, in which case the cost of the machines and the danger involved in operating them are secondary, or he figures that he can also produce machines which will be in demand under peaceable conditions. As everybody understands that if peace comes tomorrow the ardor for war machines will cool the day after, or at least that such is likely to be the result here and that Europe will take time to produce her own war machines, the business viewpoint would seem to be mostly concerned with machines for peace and to rest largely on the assumption that some change has taken place which now makes the aeroplane fit for peace, although the public said unmistakably before the war that it held a different opinion.

Looks Like Doubtful Business

As heroism without due cause has no strong appeal, a good measure of safety is probably indispensable to make the aeroplane a popular civilian success, and it must be a safety that is under control by caution, not depending too much on high skill or the mere unlikelihood of encountering high-stress conditions in the elements—in the air, on water, on the ground.

Very high motor power, very great size of the machine, very great cost are all factors which would militate against popularity. The need of large storage space and sheds, large and smooth starting and landing ground would constitute another objection. Necessity for rising high in the air to be out of danger from gusts of wind would interfere with the acquirement of skill, and the civilian aeroplane must be one that invites to practice.

Taking all these things into consideration, one asks: How must then the aeroplane be constituted which shall be safe enough, good enough, cheap enough and interesting enough for the average American civilian of the class who under present conditions would consider the aeroplane at all as an instrument for sport or transportation? Does such a type exist or must it be created?

The Santos Dumont aeroplane with which Garros gained his skill at first had strong features to recommend it. It was light with a relatively large sustentation area and only a

small motor. It fluttered over the ground as a butterfly and bounced as a rubber ball, harmlessly, when it struck rough spots before rising. Its angle of incidence was naturally high until it got up and some speed was gained. But it was not much more than a learning-machine. It was less safe in the air than the machines—heavier, more powerful and with narrower and more flattened planes—which gave beginners more trouble and danger on the starting ground. It was a monoplane, which is not what war experience now recommends. On the other hand, the monoplane can readily be made with folding wings, so as to require small storage space, while no biplane has so far been made which can be taken down or set up in a few minutes by hitching the two planes separately to the body of the machine.

Perhaps easy storing is one of the requirements which must be sacrificed for the present, and in that case one turns to the demand for safe starting and safe practice without the handicap of demountable construction but short of one popular advantage. The hydro-aeroplane seems at once the most plausible type. It is practically always a biplane but with the lower plane shorter and stouter than the upper. It might be called a sesquiplane. It can be stored at the edge of a lake or river in most cases, which is usually convenient and inexpensive, but with a construction adapted for starting from water only its use would be too restricted from a business point of view. The popular type must be easy to start on either land or water, or at least easily convertible in this respect. No type of this description has made its appearance as yet. Dimensions and prices are far beyond popular limits.

In order to really invite to such frequent practice and use as alone can make a vehicle of any kind popular, the hydro-aeroplane should be sure to dump its pilot into the water gently and free of entanglements in case of a spill, or else to come down upright with the occupants on top.

The most diligent survey fails to disclose any basis for expecting a boom in private aeroplanes for either sport or utility until some radical change has been brought about in all the features relating to the convenience and safety in using them. Farmers are as a class best situated for making use of aeroplanes. People living or summering at lakes or sea shore or in the mountains come next in numbers. But one cannot imagine that many of these classes would invest in machines costing much more than one thousand dollars or machines which their children could not be trusted to use. Automobile manufacturers cannot but know that this market will not pay for the work of gradually developing an individual aeroplane from the data at present available until it may finally meet popular requirements. The transition stages in such a development are missing. But as an industrial sport for wealthy manufacturers participation in such a development should be interesting.

The aeroplane omnibus, stage or excursion craft is more nearly in line with the improvements which the aeroplane has received during these two years of war than the low-priced individual machine. It may be reserved for the public service aeroplane of large size to familiarize people with flying and constructively to bridge the gap separating the existing types of "heavier than air machines" from popularity.

Universal Has Cast Iron Bearing

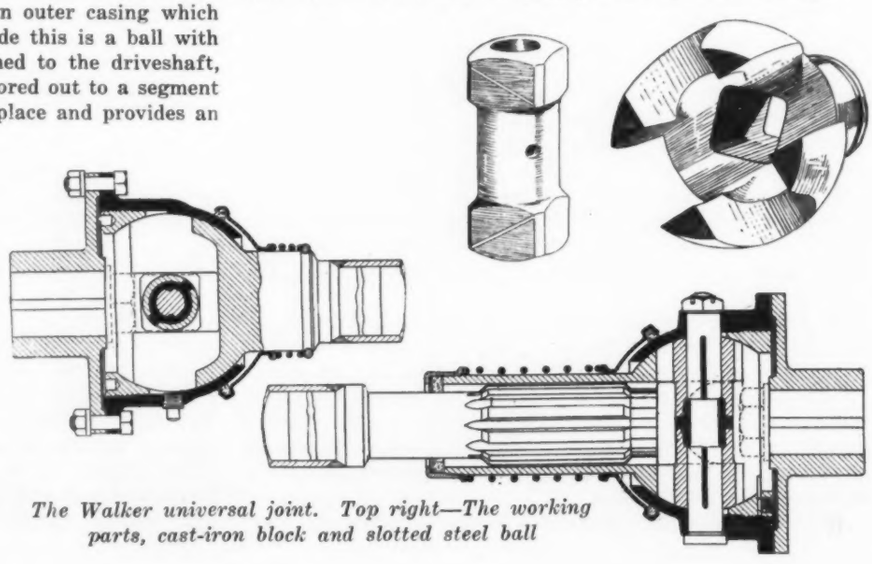
Large Surface and Ready Adjustment Features of New Joint—Contains Lubricant Which Is Distributed Automatically to Working Parts

THERE seems no end to the possibilities of universal joint design as, despite the almost endless number of patterns already in use, patents for new types are granted fairly often. The latest to appear on the market is the Walker, made by the Walker Joint Co., Detroit, and this is interesting in many ways. Firstly, it has a bearing surface composed of cast iron working against steel; it has also an adjustment for taking up slack and uses the principle of the spherical joint to hold the driveshaft absolutely central, while also insuring the retention of lubricant.

The details are made amply clear by the illustrations, the sectional cut showing two right-angle views through the center of the joint and the perspective sketch the two main parts of the joint. Briefly, there is an outer casing which is bored out to a spherical form. Inside this is a ball with a shaft integral with it that is attached to the driveshaft, and an adjustable securing ring, also bored out to a segment of a sphere, holds the ball member in place and provides an adjustment for keeping the ball from developing any shake in its casing.

In the ball four slots are cut, as shown in the sketch; two of these slots are rough, being merely for the sake of saving weight, while the other two are finished accurately. Within the latter slots is placed the square-ended block, also shown in the sketch, and it is this that is the cast-iron part. There are two holes opposite each other in the outside casing, and a bolt is passed through these holes and also through the cast-iron piece. The bolt is locked in the casing so the cast-iron block turns on the bolt, giving motion in one direction, while the ball can rock to and fro within the limits of the slots, thus giving motion in the other direction.

It is easy to see that the whole joint, when assembled, can retain a considerable quantity of lubricant. In the sketch it will be noticed that there are holes drilled near the middle of the cast-iron piece, and in the sectional drawings the path of the oil within the bolt is shown by solid black. Centrifugal force takes oil or thin grease from the center and carries it out to the working surfaces at the ends. When it escapes from these it lubricates the spherical surfaces, and the rocking of the ball keeps all the lubricant churned up so that there is a continual circulation. The remaining mechanical details are made completely clear by the drawings.



The Walker universal joint. Top right—The working parts, cast-iron block and slotted steel ball